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PRELIMINARY REPORT OF THE BOARD OF INVESTIGATION AND COORDINATION *

FOREWORD

In presenting this preliminary installment of its Report, the Board of Investigation and Coordination has in view the sequel of constructive activities to follow the work of investigation carried on during the past three years. It is the hope of the Board that this program may go forward in the colleges at once, concurrently with important joint activities by the Society with the professional engineering societies, the industries, the secondary schools and the non-engineering colleges.

The proposed program calls for the simultaneous consideration of problems of educational policy and practice by the several engineering colleges under the coordinating guidance of the Board. It is suggested that the colleges appoint committees on educational policy, with sub-committees where desirable, and that the Staff shall be at the service of these committees in an advisory capacity and as a clearing house for information.

The Board has considered certain broad questions of policy and has envisaged the wide range of educational activities in which engineering education is included, seeking to indicate its appropriate scope and character. The Report also includes a group of recommendations of more specific type, touching upon problems of general concern to all engineering colleges.

The Board recognizes that engineering education covers a wide range of activities in diverse types of institutions and must be adjusted to very uneven conditions of admission and preparatory education. The Board believes that the progress

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of engineering education will be best served through the freedom and initiative of the individual colleges, and deems it inappropriate to propose either measures of standardization or specific procedures for particular conditions.

I. STRUCTURE OF UNDERGRADUATE ENGINEERING CURRICULA

Fundamental Conception.—The basic process of engineering education should be an undergraduate curriculum of coherent and integral structure, directed to the grounding of the student in the principles and methods of engineering and to those elements of liberal culture which serve to fit the engineer for a worthy place in human society and to enrich his personal life. To serve its purpose adequately this undergraduate program of studies should provide a basis for the three types of activity common to all engineering, namely:

1. The control and utilization of the forces, materials and energy of nature;
2. The organization of human effort for these purposes; and
3. The estimation of costs and appraisal of values, both economic and social, involved in these activities.[1]

An educational process appropriate to these purposes can not be narrowly technical. Given a proper choice of subject matter and activity, reinforced by the incentive of purpose, the inspiration of professional ideals and the effect of a professional objective in bringing the entire process to a focus, the result of engineering education should be a sound, general development, worthy to be compared with the result of any other collegiate program. In short, good engineering education is good general education; there is no warrant for assuming that the two have different ultimate purposes which necessitate two distinct programs for the engineering student.

A Coherent Curriculum Essential.—To be sound, an engineering education must be more than the mere sum of its parts; it must be conceived and planned as a whole. While

it is desirable to provide a reasonable degree of flexibility within an orderly curriculum structure through a moderate diversity of programs, some provision for the election of individual subjects and group options, and the gradual introduction of some more autonomous plan of work for selected upper-classmen, any tendency toward disintegration into a loose succession of uncoordinated subjects is to be vigorously opposed. The coherent, integral structure of the engineering curriculum at its best, with its logical sequences running from beginning to end, drawing on many fields of knowledge, but progressively bringing the student's efforts to a focus in a well-defined realm, is probably its most distinctive merit.[2]

Scholastic and Post-Scholastic Training.—The objectives of engineering education are of such extent that unlimited time might be devoted to their attainment. Money costs, the mating instinct and the time demanded for making adjustment to practical life, tend to set a time limit to education as a formal, scholastic process and to push a growing and important part of it over into the early years of productive life.[3] This principle should be frankly accepted in engineering education by recognition of the fact that the process is divided into scholastic and post-scholastic stages. A college training which prepares for entry to productive life at a normal age of from twenty-two to twenty-three is as much as can be justified for the majority of engineering students. If college training as a formal, full-time process for this majority is to be extended, this end must be accomplished through an earlier completion of preparatory studies. For the time being, limitations of the formal scholastic program must be offset by more extended provision for further training after graduation.[4] The mastery of much of the specialized knowledge and technique of engineering properly belongs to this period.

SUGGESTIONS AND RECOMMENDATIONS

A. Length and Quantitative Content.

1. The normal length of the undergraduate curriculum should remain four academic years. This proposal assumes

that no attempt will be made to train men to be either specialists or all-round engineers in that period and that further training is required to fit men to engage in the more advanced engineering specialties.

2. The curriculum of four years should not, in general, require in excess of 144 credit units, measured in semester-hours, or their equivalent, exclusive of required physical and military training and required summer courses.[5] The range of from sixteen to eighteen credit-hours per week is suggested as a norm, assuming each credit-hour to represent a work load of three clock hours.

3. Six distinct subjects of instruction to be carried simultaneously are suggested as a maximum limit consistent with efficiency of effort.[6] (Closely correlated work in class and laboratory or drawing room may properly be considered a single subject.)

B. Diversity of Programs.

4. As a general practice, undergraduate curricula should be differentiated from each other to a moderate degree only.[7] As means to this end:

a. There should be an initial period, preferably of not less than a complete academic year, with a common curriculum for all engineering students;

b. There should normally be a final period, preferably of one academic year, of considerable differentiation between the several curricula, for the purpose of bringing engineering principles to a focus and of gaining the cumulative effect of narrowing the field of effort;

c. The degree of differentiation in the intervening period should fit local circumstances; it should increase progressively, but may well remain relatively small in the majority of cases, particularly between such closely related fields as mechanical and electrical engineering. (In the smaller institutions an effective plan may be worked out with only a single, final year of differentiation between civil, mechanical and electrical engineering.)

5. The primary basis of differentiation of undergraduate curricula should be the historic major divisions of the engineering profession, namely: Civil, mining and metallurgical, mechanical, electrical and chemical engineering. Differentiation according to functional types of activity, including administration and management, should be within these major divisions and should appear toward the end of the program.[8,9]

6. Options which recognize the principal technical and functional subdivisions of the major professional fields of engineering may properly be provided in the final year of the several curricula to an extent consistent with the size and resources of the particular institution, but without pretense of giving a detailed professional training.

7. As far as practicable it is desirable that all curricula should be of equal merit and rigor, and that suitable accommodations to differences of ability should be made within each of them rather than through essentially dissimilar programs.

8. Curricula in civil, mechanical, electrical and chemical engineering may properly be offered in the majority of engineering colleges.[10] Curricula in mineral technology should be offered in only a minority of institutions. Curricula in naval architecture, architectural engineering, ceramic engineering, aeronautic engineering and similar specialties, should be offered to undergraduates in exceptional institutions only.

C. Contents and Order.

9. There should be a progressive sequence of the fundamental sciences and the related engineering principles, extending through the entire curriculum.[2] This sequence should be marked by close coordination of order, content and emphasis of the several divisions of subject matter; this coordination should not be so narrow, however, as to limit the treatment of the basic sciences to their specific uses as tools in engineering.

10. There should be a band of humanistic subjects extending throughout the curriculum.[11,12] To increase the range of

such work available in addition to required work in English and economics, much of it may properly be on an elective basis.

11. The following subjects should be included in *all* engineering curricula, although not necessarily to the same extent:[13]

a. Mathematics, to include differential and integral calculus;
b. Inorganic chemistry, with laboratory;
c. General physics, with laboratory;
d. English composition, speech and literature;
e. General economics;
f. Introduction to the economics of engineering;
g. Introduction to the law of contracts;
h. Drawing and the principles of graphics;
i. Technical mechanics;
j. Mechanics of materials, with laboratory;
k. Introduction to hydraulics;
l. Introduction to heat power engineering, with laboratory;
m. Introduction to electrical engineering, with laboratory.

(A careful analysis, confirmed by "A Study of Engineering Curricula," by Walton C. John, indicates that the time allotted to these subjects constitutes approximately two-thirds of the requirements for graduation.)

12. Modern foreign languages should not be required of all engineering students, but should be offered as electives in all curricula in which they are not required.[14] [15] (The Board holds modern foreign languages in high esteem, both as a medium of general education and as an aid to advanced study, and suggests that all engineering students, and especially those who purpose to pursue graduate work, be advised to qualify with a reading knowledge of either French or German and preferably of both; and that such knowledge

should be acquired, wherever practicable, as a part of the student's preparatory education.)

13. The order and content of the curriculum should have regard to the enlisting and stimulation of the student's interest, to his intelligent orientation to engineering activities and traditions, and to an early try-out of his aptitude for the engineering field.[16] To serve these ends, a program of concrete exercises and projects, together with suitable lectures and conferences, may be introduced advantageously at or near the beginning of each curriculum. These activities may well be supplemented by such tests as may be found to give a valid indication of the student's scholastic and occupational aptitudes.

REFERENCES

[1] For a more complete statement of this matter, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, p. 31.

[2] For an illustration in the case of the civil engineering curriculum, see "Summary of the Fact-Gathering Stages of the Investigation of Engineering Education," *Journal of Engineering Education*, September, 1926, pp. 66–70 inc.

[3] See Report as in (1); pp. 28–29.

[4] For a further discussion of this matter by the Committee on Engineering Students and Graduates, see *Bulletin No.* 3, pp. 26–29 inc.

[5] For present graduation requirements, see "A Study of Engineering Curricula," *Journal of Engineering Education*, April, 1926, pp. 517–549 inc.; May, 1926, pp. 581–601 inc.

[6] See also *A Study of Engineering Education* by Charles R. Mann, pp. 87.

[7] For a consensus of opinion in the matter, see *Bulletin No.* 9, p. 3.

[8] For a consensus of opinion in this matter, see *Bulletin No.* 9, pp. 7–8.

[9] For a more extended discussion of the plan for the functional division of curricula, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, pp. 41–42.

[10] For statistics on enrollment in various curricula, see *Bulletin*, 1925, *No.* 45, U. S. Bureau of Education, p. 13.

[11] For a consensus of opinion in this matter, see *Bulletin No.* 9, pp. 17–19 inc.

[12] For the views of a group of younger graduates, see *Bulletin No.* 8, pp. 11–12.

[13] See *Bulletin No.* 9, pp. 9–12 inc.

[14] *Ibid.*, pp. 9–12 inc.

[15] For the views of a group of younger graduates, see *Bulletin No.* 8, p. 16.

[16] For a further discussion of this problem, see *Bulletin No.* 1, pp. 23–27 inc.

II. SOCIAL AND ECONOMIC CONTENT OF ENGINEERING CURRICULA[1]

Objectives.—There are two fairly distinct objectives to be kept in view. The first is the understanding of social institu-

tions and of the broad interplay of social forces; it is essentially philosophic and lies mainly within the educational sphere of the social scientist. The second is the capacity to deal with specific economic problems and social situations arising within the realm of engineering; it is essentially technical and is a responsibility of engineering educators.

Relations Between These Objectives.—Between these two realms of education there is as yet only a vague connection. Between *economics* and the problem of fuel *economy,* between sociology and the housing of a mining camp, there are no such detailed bonds of logic as between physics and the proper cross-section of a beam. Tangible progress in closing this gap depends equally on steps to be taken by social scientists to make their work more significant to engineers and by engineering teachers to develop more adequate methods of dealing with the technique of economy, both financial and human.

Importance to the Engineering Profession.[2]—The development of greater social insight and a larger sense of social responsibility should be a definite objective of the engineering profession if it is to gain recognition for more than its technical proficiency. At the same time it has need to improve its proficiency in dealing with problems of economy as related to the technical problems of engineering.[3] The ability of the engineer to extend his influence in industrial organizations and in public life, to claim his due share of leadership and to discharge more adequately his function in society at large, now appears to hinge primarily on his attainment of greater competency and greater recognition on the economic and social side of his work. The public has ample confidence in his ability to deal with material problems.

Place in the Curriculum.[4 5 6]—These considerations lend a high importance to the social sciences as an essential part of an adequate engineering education.[7] General economics is entitled to a place in all engineering curricula as a required subject. History, political science and sociology are highly desirable subjects and deserve to be included, either as re-

quired or elective subjects, wherever possible. These subjects should be taught by competent exponents and primarily for cultural rather than technical ends. These cultural ends, however, should not be left wholly vague and undefined, but should have in view the importance to the engineer of grasping the social significance of his work and of relating it effectively to other persons, social groups and social institutions.

Emphasis on Engineering Economy.[8 9]—Considerations of social and financial economy deserve a larger place in all distinctly engineering subjects.[10] More specific attention should be given to the criteria by which the relative economy of different procedures may be judged and to the technique by which economy may be analysed. The practicability of creating a separate subject of instruction for this purpose, to be handled either by formal subject matter or by a case system of teaching, has not yet been determined. The experiences of the colleges of business administration with parallel problems are not wholly reassuring. There is an open field for experiment by engineering colleges.

SUGGESTIONS AND RECOMMENDATIONS[6]

1. General economics should be included in all engineering curricula and should preferably extend throughout a complete academic year.[11]

2. The subject of general economics should be taught by an economist of thorough competency, but with proper accommodation to the interests and view-points of engineering students. The aim should be to place economics on a plane collateral with the mathematical and physical sciences as one of the foundation subjects of the curriculum and to create an equal degree of correlation between economics and the engineering subjects proper, in line with the recommendations of the Committee on Economic Content.

3. History, political science and sociology should be included in engineering curricula, either as required or elective matter.[12]

4. The criteria and technique of engineering economy, as related to costs, economy of design, and economy of selection and application, should be taught by engineers in connection with engineering subjects.[13] A larger emphasis on this aspect of engineering is clearly warranted.[14] [15]

5. Adequate and sustained emphasis should be given to the bearings of engineering on the broader problems of society and to the social responsibilities of the engineering profession. This end should be sought implicitly by frequent comments and allusions introduced by teachers in the regular courses of instruction. It should also be sought explicitly through subjects of tutorial instruction, supplementary lectures, articles in student publications, activities of student organizations and recommended reading. The aim should be to indoctrinate the student with a sense of social obligation which will survive pre-occupations of technical detail in his early experience and determine his attitude in the more responsible years of his maturity.

REFERENCES

[1] For a summary of present provisions in the curriculum for economics and related subjects, see *Preliminary Report of the Committee on Economic Content of Engineering Education,* presented at the annual meeting of the Society in June, 1926, and available in printed form at the office of the Director, 33 West 39th Street, New York City.

[2] See *Bulletin,* 1919, *No.* 58, and *Bulletin,* 1924, *No.* 16, U. S. Bureau of Education.

[3] For a consensus of opinion regarding the present proficiency of engineering graduates in dealing with economic problems, see *Bulletin No.* 9, pp. 12–13.

[4] For a consensus of opinion regarding provision to be made in the curriculum for economics and related subjects, see *Bulletin No.* 9, pp. 13–14.

[5] For recommendations previously presented to the Society in this matter, see *Proceedings,* Vol. XXV, pp. 225–230 inc., and Vol. XXVI, pp. 202–203, and pp. 218–225 inc.

[6] For specific recommendations, see *Report of November,* 1926, of the Committee on Economic Content of Engineering Education.

[7] For trends in relation to the place of social sciences in the curriculum, see *Journal of Engineering Education,* June, 1926, pp. 663–664.

[8] For opinions of engineering graduates of all courses, see *Bulletin No.* 8, pp. 15, 16 and 19.

[9] For opinions of a group of recent electrical engineering graduates, see *Bulletin No.* 8, pp. 13–14.

[10] For a consensus of opinions of influential engineers and engineering teachers, see *Bulletin No.* 9, pp. 13–14.

[11] For recommendation as to subjects to be included in all curricula, see Section I of this report, p. 326.
[12] For consensus of opinions of engineering teachers, see *Bulletin No. 9*, p. 11.
[13] *Ibid.*, pp. 13–14.
[14] *Ibid.*, p. 13.
[15] See *A Study of Engineering Education* by Charles R. Mann, p. 99.

III. ADMISSIONS [1]

Duty to the Engineering Profession.—The engineering colleges serve as the principal agency for the recruitment of the engineering profession and largely control its future through the qualifications and character of the students whom they attract and admit to their courses.[2] Due regard for the profession and for the industries and public which it serves calls for an educational policy designed to protect and elevate professional standards rather than to increase the number of engineering colleges; to improve the quality of student personnel rather than to expand enrollments. The pressure for more extended provision for technical education and the demand for increased technical personnel should be met for the present by the expansion of the facilities and programs of non-collegiate types of training.[3]

Admission Policies.—Policies of admission to engineering colleges should have in view the positive attraction and selection of suitable personnel. There are two immediate ends to be achieved. The first is the adoption of effectual methods of educational guidance through the cooperation of engineering teachers and leaders of the profession on one hand with secondary school teachers, parents, and other counsellors of youth on the other. The means to this end have been outlined in the report of the Committee on Students and Graduates.[4] The second end to be sought is the development and application by the engineering colleges of selective methods of admission.[5]

As stated elsewhere, engineering curricula should preserve an undergraduate status.[6] The requirements for admission to engineering colleges should accordingly be articulated with the curricula and graduation requirements of secondary

schools. It is essential therefore that the colleges exert their influence to insure the inclusion in high school curricula of those subjects which are a necessary preparation for engineering study.[7] Even though the subject matter of the high school curriculum meets these conditions, the qualitative requirements for graduation in a popular system of secondary education cannot be expected to discriminate between grades of ability and types of aptitude to the extent needed in engineering education. Supplementary selective tests [8] designed to identify and admit only those who are properly qualified by endowment and preparation should therefore constitute an essential part of the normal admission procedure of engineering colleges. The evidence is conclusive that admission by certificate without supplementary selective requirements results in the admission of large numbers who are not qualified successfully to pursue an engineering program of four years' duration.[9]

Admission by examination only is a relatively exceptional practice [10] among engineering colleges at the present time and, whatever its merits, bids fair to remain so. It cannot be determined whether the advantages of the larger proportion of well qualified students and the lower elimination ratio which are associated with this practice are to be attributed to the inherent merits of the examination method or to other factors.

Admission to Advanced Standing.[11]—The conditions of admission to advanced standing which apply to graduates of junior colleges and to students who have completed all or the major part of a general curriculum in arts and sciences should be favorable to their early adjustment and progress, while guarding against the elimination or curtailment of any essential scientific or engineering subject. The conditions should be set forth as explicitly as possible and should afford a reasonable degree of elasticity in the adjustment of details.

SUGGESTIONS AND RECOMMENDATIONS

A. Educational Guidance Before Admission.

1. Literature designed to acquaint high school students with engineering and with engineering education should be

prepared by representatives of this Society in cooperation with representatives of the secondary schools. It should follow the lines laid down by the Report of the Committee on Engineering Students and Graduates.[12] It should be made available for distribution by the colleges.

2. Sections and branches of the Society may well include conferences with groups of secondary school teachers and with parent-teacher associations in their activities.

3. Addresses by engineering teachers before high school student bodies, with provision for personal interviews with students who seek them, should be arranged on the initiative of individual colleges.

B. Joint Agency of Cooperation.

4. A joint agency should be created on the initiative of this Society for cooperation with organizations of secondary schools and secondary school teachers.[13] Its activities should include steps toward educational guidance as outlined above, efforts to strengthen the status in the secondary curriculum of subjects which are an essential preparation for engineering study, joint formulation of proper entrance requirements and tests, and the development of means for the more discriminating selection of entering students.

C. Admission Procedure.[14]

5. Admission by certificate should be accompanied by more selective methods, involving any or all of the following:

a. Scholastic records in mathematics, science and English above mere passing grades;

b. A general scholastic standing in a designated fraction of the class;

c. Special recommendation of fitness by the high school principal;

d. A test of general intelligence;

e. Training and aptitude tests in specific subjects;

f. A physical and health examination to discover and pro-

vide for remediable defects and eliminate in advance those too seriously handicapped for the successful pursuit of a rigorous college program.

6. Supplementary selective tests should preferably be administered on the premises of the secondary schools immediately prior to the student's graduation. Procedures for administering the tests should be specified by the colleges and provision made for forwarding the test papers with the transcript of the student's record and the principal's recommendation.

7. Where legal or administrative difficulties prevent the formal use of selective measures to supplement admission by certificate, equivalent results should be sought through advisory measures, operating either through high school principals or by direct counsel to prospective students and their parents.

8. The practice of admitting students who are conditioned should be discontinued since this practice tends to nullify the real and potent influence a fixed standard might exert.[15]

9. The process of admission should include as an essential feature a preliminary period of orientation and adjustment to college life and engineering study.[16] One acceptable means of accomplishing this end is a period of organized activity prior to the regular program of work, generally known as freshman week.

10. To facilitate the entrance of desirable students to advanced standing and to minimize irregularities in their programs short intensive courses in such subjects as drawing, graphics, shop-work, elementary laboratory work and the like should be provided for make-up purposes and such students should be permitted, where necessary, to pursue these make-up courses in part without formal supervision.

REFERENCES

[1] For present admission practices and requirements, see *Bulletin No.* 2, pp. 22–26 inc. Also see "A Study of Engineering Curricula," *Journal of Engineering Education*, April, 1926, pp. 523–530 inc.

[3] For a more extended statement of this matter, see *Bulletin No.* 1, pp. 18–20 inc.

[4] For a further discussion of this matter, see Preliminary Report of the Director, *Journal of Engineering Education,* September, 1926, pp. 24–26 inc.

[5] For recommendations of the Committee on Engineering Students and Graduates in this matter, see *Bulletin No.* 1, pp. 12–18 inc.

[6] For recommendations of the Committee on Engineering Students and Graduates in this matter, see *Bulletin No.* 1, pp. 20–22 inc.

[7] See Section I of this report, p. 322; also Section VII, p. 352.

[8] For a further discussion also see *Bulletin No.* 2, pp. 6–7.

[9] For a brief discussion of aptitude and training tests, see "Iowa Placement Examinations," *Journal of Engineering Education,* October, 1925, pp. 158–163 inc.

[10] For a discussion and statistics of eliminations, see *Bulletin No.* 2, pp. 7–13 inc., and pp. 29–32 inc.

[11] For the number of institutions admitting exclusively or principally by examination, see *Bulletin No.* 2, p. 4.

[12] For a more extended discussion, see Preliminary Report of the Director, *Journal of Engineering Education,* September, 1926, p. 29.

[13] For recommendations of the Committee on Engineering Students and Graduates, see *Bulletin No.* 1, pp. 12–18 inc.

[14] See also Preliminary Report of the Director, *Journal of Engineering Education,* September, 1926, p. 36.

[15] For recommendations of the Committee on Engineering Students and Graduates, see *Bulletin No.* 1, pp. 18–21 inc.

[16] See *Bulletin No.* 2, pp. 5 and 26.

[17] For recommendations of the Committee on Engineering Students and Graduates, see *Bulletin No.* 1, pp. 23–26 inc.

IV. THE NON-GRADUATING STUDENT

A Problem to be Faced.—The present proportion of non-graduating students in engineering colleges is plainly excessive and indicates a negative handling of a group of important problems.[1] More positive and constructive measures are needed. There are obvious possibilities of betterment in more selective methods of admission, in improved methods of sectioning and teaching and in a type of personnel administration which seeks to determine causes as well as apply remedial measures. These remedial measures should include facilities for the transfer to other educational programs of students of good general ability who are handicapped in engineering by misdirected interest and lack of aptitude. Relaxation of graduation requirements in engineering cannot be considered, while the setting up of semi-engineering curricula of less rigor and difficulty than normal engineering programs is an expedient of very doubtful propriety. The placing of

an intermediate goal in the engineering program and the restricting quite closely of admissions to the subsequent stage of work deserve special consideration.

Selective Admission.[2]—The most far-reaching remedy for the present situation is to be sought through selective admission at the outset. To gain the most constructive ends, the introduction of selective methods of admission to engineering colleges ought to be accompanied by a wide-spread provision of facilities for briefer and more intensive programs of technical education, better adapted than the present college programs to the interests, abilities and financial limitations of a large percentage of those who now seek admission to engineering colleges.[3] Until such alternative programs of technical training are adequately provided, selective admission will meet resistance and difficulty in publicly supported institutions. Unless more selective methods of admission are employed there will be a persistent temptation to make a compromise of standards between what an adequate engineering program should require and what a majority of the students actually admitted are able to do.

The Intermediate Goal.—The recognition of an intermediate goal by a certificate which may be awarded at the end of the sophomore year as a form of honorable dismissal appears to be a desirable expedient,[4 5] especially under conditions which make selective admission impracticable for the present and in regions where non-collegiate types of technical education are now inadequately provided for. A committee of the Association of University Professors recently presented a proposal which is in harmony with this plan:[6]

> "Every college should admit to its junior class a specified smaller number of students than it admits to its freshman class; selection should be made on a competitive basis and those who fail should be honorably dismissed with a certificate."

The plan of selective sectioning in fundamental subjects according to ability, preparation and working pace is favorable to earnest but mediocre students and would doubtless aid

many such to complete a two-year introductory program who ought not to be encouraged or even permitted to attempt more advanced work.

SUGGESTIONS AND RECOMMENDATIONS

1. A selective plan of admission, designed to check the entrance of improperly qualified students at the outset, is highly desirable.[2]

2. Encouragement and assistance should be given to the establishment and development of institutions offering briefer and more intensive programs of technical education which are better suited to many students who now enter engineering colleges and are eliminated as non-graduates.[3]

3. Students with seriously deficient preparation and those who persist in a negligent attitude, after suitable warning and counsel, should be eliminated during the freshman year.[7]

4. The plan of selective sectioning in basic subjects should be introduced for the benefit of gifted and mediocre students alike.[8]

5. Unless the plan of admission to the freshman year is highly selective, admission to the junior year should be on a selective basis.[5]

6. Students who complete two years' work with only a fair record and whose misdirected interest or lack of aptitude for engineering unfit them for the more advanced work of the upper years, should have the option of transfer to non-engineering programs or of honorable dismissal with a certificate.[6]

7. Where provision must be made for large numbers of probable non-graduates, as much of the more concrete and practical content of the curriculum should be placed in the first two years as is feasible without detriment to the preparation of those who are to continue.[9]

8. Competent personnel supervision, particularly adapted to deal constructively through diagnosis and remedial measures with cases of impending failure, should be provided wherever practicable.

REFERENCES

[1] For statistics of eliminations in engineering and other curricula, see *Bulletin No.* 2, pp. 7–11 inc., and pp. 28–32 inc.

For conclusions of the Committee on Admissions and Eliminations, see *Bulletin No.* 2, p. 17.

[2] See also Section III of this report, p. 333.

[3] For a further discussion of this matter, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, pp. 24–26 inc.

[4] See report of Committee on Engineering Students and Graduates, *Bulletin No.* 1, pp. 27–28.

[5] See Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, pp. 47–49 inc.

[6] See *School and Society* for October 23, 1926, p. 510.

[7] For the majority opinion of faculties as to the propriety of such eliminations, see *Bulletin No.* 2, p. 19.

[8] See *Bulletin of American Association of University Professors*, Vol. IX, No. 6, pp. 9–24 inc., October, 1923.

[9] See *A Study of Engineering Education* by Charles R. Mann, p. 88.

V. THE WORK OF EXCEPTIONALLY GIFTED STUDENTS

Ends to be Sought.—The Board accepts the principle of the accommodation of educational methods to individual differences.[1] [2] The principle does not admit, however, of an extreme application in engineering education where general training is blended with professional discipline.[3] The present scheme of closely supervised work in connection with an orderly plan of class and laboratory exercises is well adapted to the needs of the majority of engineering students. It is desirable to make some modification in the direction of increased student autonomy in the upper years without sacrificing the essential features and merits of this plan. Some more distinctive provision, however, should be made for the needs of exceptionally able and self-reliant students who fail to receive the maximum stimulation of their initiative and resourcefulness in closely regimented work.

The Regime for Under-Classmen.—The mental immaturity of entering students and the soft quality of much of their preparation[4] seem to make the preservation of the present strict regime of work inevitable during the first two years, if deficits in preparation are to be made good, solid foundations laid in basic subjects and mental discipline up-graded. As-

sociated with this strict regime there should be a flexible scheme of sectioning adapted to different grades of ability.[5] The advantage conferred by selective sectioning upon the best qualified groups should be employed for the enrichment of content and the pursuit of a higher quality of achievement rather than the shortening of the period devoted to a fixed quota of work.

Autonomy for Upper-Classmen.—The present tendency is to prolong the attitude of detailed supervision and solicitude for the student's progress, which is necessary and proper in dealing with under-classmen, into the upper years. Assuming that a deliberate sifting process is to be applied at the transition from the second to the third year [6] with a view to making the upper classes reasonably homogeneous in ability, the regime of work for all upper-classmen may well be modified gradually in the direction of greater student autonomy. This result may be sought through less strict regulation of attendance, larger scale assignments of work, reduced dependence on single text-books and other consolidated sources of materials, a replacement of simplified exercises by problems and projects of substantially real magnitude and complexity, and the adoption of tests of achievement more comprehensive than those now employed. Formal classroom teaching may well be supplemented by a certain amount of semi-individual tutorial teaching.

Special Program for Selected Men.[7]—In addition to providing a reasonable increase of autonomy for all upper-classmen, as suggested above, it is desirable that more extended steps be taken to meet the needs of exceptional students who may be expected to accomplish better results by methods of semi-independent work than under the close supervision employed with the regular groups. Any highly autonomous plan of work should be introduced in engineering colleges experimentally and extended cautiously. It will require time to build up a supporting body of tradition needed for the success of the plan, to insure its acceptance by the best qualified students and the exclusion of students of a high order of

routine excellence, to create the essential relationship of joint effort between the students and their faculty mentors, to develop a goal of superior excellence rather than a wider spread of effort, and to devise appropriate measures of the grade of attainment sought.

The pioneer work needed to assure the successful establishment of highly autonomous programs for exceptional students is presumably a duty to be undertaken on behalf of the whole body of engineering colleges by those institutions which have exceptional resources, facilities and freedom. The results of their experience should be given wide circulation and study among their sister colleges. For the present, the efforts of the majority of the institutions should be directed to increasing the element of autonomy and flexibility in the work of all upper-classmen, as suggested above.

SUMMARY OF SUGGESTIONS AND RECOMMENDATIONS

1. The sectioning of basic subjects pursued by large groups of students, according to ability, preparation and pace, is advised. Use should be made of this plan to enrich the content and improve the quality of the work of the best qualified groups, rather than to shorten the time to achieve a standardized end.

2. The relatively strict regime of work now in general use should be continued for all groups in the first two years.

3. A selective process of admission to the third year of the course is advised in order to insure reasonable homogeneity of ability in upper classes.

4. The plan of work in the upper years should be modified to require a greater degree of self-direction on the part of all students. This result should be accomplished for the majority by modifications in a systematic program of class and laboratory exercises, supplemented by a limited amount of tutorial instruction.

5. A highly autonomous program for selected and exceptional upper-classmen should be introduced in a few institutions specially qualified to develop the method experimentally.

REFERENCES

[1] See *Bulletin No. 52 of the National Research Council*, "Honors Courses in American Colleges and Universities," by Frank Aydelotte.

[2] See "Recognition of the Individual," by Carl E. Seashore, *Proceedings*, Vol. XXXII, pp. 111–122 inc.

[3] See "Summary of the Fact-Gathering Stages of the Investigation," *Journal of Engineering Education*, September, 1926, p. 64.

[4] For findings of the Committee on Engineering Students and Graduates relating to quality of preparation, see *Bulletin No. 1*, p. 8.

[5] See *Bulletin of the American Association of University Professors*, Vol. IX, No. 6, pp. 9–25 inc., October, 1923.

[6] See Section IV of this series, p. 336.

VI. TEACHING PERSONNEL

Need for Action.—Efforts to develop, broaden and enrich engineering education will be largely unavailing unless teaching service is able to enlist and hold able and inspiring men. The present situation, as far as statistical data can reveal it, is marked by negative virtues rather than glaring defects.[1] There is abundant evidence that increasing difficulty is being experienced in filling vacancies of the highest importance, that the more gifted younger men in teaching ranks are not being developed to the same degree as their equals in active life and that the administrative heads of institutions have not yet given the same concern to attracting and holding men of high professional distinction to chairs of engineering that has been shown in certain other realms of professional education.[2]

Prompt action should be taken to meet and offset the declining drawing power of the teaching career in engineering before a more critical situation arises.[3] Recent years have greatly multiplied the opportunities afforded in engineering practice for human service and leadership of the broader kind and for the attainment of high scientific distinction. Taken in conjunction with notably superior financial rewards, these conditions have tended to make a teaching career relatively less attractive to men of the type most desired for positions of leadership in education. A laissez-faire policy will not meet this situation.

Modes of Recruitment.—The primary mode of recruitment

must clearly be the enlistment of young men for a teaching career at or near the time of their entry into active life.[4] The appointment of distinguished engineers from private or industrial practice bids fair to remain a secondary, though by no means exceptional or unimportant, mode of recruitment of the major teaching and administrative posts. Unless the rewards and attractions of these posts are such that notable men can be drawn to them from practice the ablest young men can not be induced to remain in a teaching career and advance to like responsibilities through the teaching ranks.

Development of Younger Men.—Positive measures should be taken by the colleges to insure the proper preparation and development of their younger teachers.[5] Considering the inherent handicaps to be overcome, it appears to be even more inappropriate and ineffectual for the engineering colleges to leave the professional development of their teaching personnel to the initiative of the individuals than such a policy would be in the industries. The Society, as a joint agency of the engineering colleges, should have an important share in these activities.

SUGGESTIONS AND RECOMMENDATIONS

1. Each engineering college should have a carefully worked-out policy and program for the enlistment and up-building of its teaching staff, to include definite plans for:

a. Directing the attention of promising young men to a teaching career;
b. Guiding prospects for teaching appointments into suitable programs of advanced study in strong graduate schools, often in other institutions;[6]
c. Guiding prospects for teaching appointments into suitable programs of engineering experience;[7]
d. Assisting the younger teachers to make and build up professional contacts and non-teaching activities, through association with practicing engineers, industrial organizations and professional societies;[7]

e. Promotion of research, preferably with the direct co-operation of industries, professional societies and trade associations, as a means of development for the younger men of the teaching staffs;[8]
f. Introducing the younger teachers to the art and science of teaching by direct instruction, individual coaching, apprenticeship, group conferences and intensive training schools conducted by the engineering colleges in common;[9]
g. Sabbatical leaves and exchanges between institutions to increase the opportunity for travel, observation and other broadening experiences;[9]
h. Budgetary provision for making these plans operative.

2. To supplement the work of individual colleges for the up-building of their younger teachers, there should be organized activities conducted by the Society, to include:

a. Schools to be held in vacation periods for intensive training in the art and science of teaching as applied to engineering subjects;
b. Systematic joint efforts with professional societies to develop the professional standing of young teachers through committee appointments and through enlistment in the local and regional activities of engineering societies;
c. Systematic joint efforts with industrial organizations to facilitate the access of young teachers to desirable experience and other professional contacts.

3. The engineering colleges should aim to establish a scale of compensation, including economic protection and retirement features, and a plan of tenure for engineering teachers, which correspond closely to the status of engineers of like maturity and of substantial attainments in the more stable industrial organizations.[10]

4. The establishment of an economic status for engineering teachers such as that proposed in (3) above should be regarded by the colleges as a prior obligation to expansion into

new fields of work and, in general, to extension of physical facilities.

5. The participation of engineering teachers in remunerative practice to a degree which augments their usefulness as teachers and educational administrators should be encouraged and should not be penalized in fixing teaching salaries.[7] Promotion, however, should not be contingent on these means of advancing professional standing to the disadvantage of research, authorship, excellence of teaching, service to professional societies, and contributions to the advancement of educational methods.

6. Teaching loads should presuppose that the engineering teacher does not restrict his activities to instruction and incidental administrative duties, but that he is expected to be a contributor to the progress of engineering science and art. In general, the load of a teacher of maturity should not exceed fifteen hours of instruction per week.[4]

REFERENCES

[1] Summary of statistics regarding engineering teaching personnel will be found in *Bulletin No.* 4, Part III, pp. 33–45 inc.

[2] For further discussion by the Committee on Teaching Personnel, see *Bulletin No.* 4, pp. 18–19.

[3] *Ibid.*, p. 32.

[4] *Ibid.*, pp. 2–4 inc., and p. 33.

[5] For present provisions in this matter, see *Bulletin No.* 4, pp. 15–17 inc. For conclusions and recommendations of the Committee on Teaching Personnel in the matter of the development of teachers, see *Bulletin No.* 4, pp. 27–32 inc.

[6] For recommendations of the Committee on Teaching Personnel, see *Bulletin No.* 4, pp. 30–31.

[7] *Ibid.*, pp. 28 and 29.

[8] *Ibid.*, pp. 12 and 39.

[9] *Ibid.*, pp. 15 and 29.

[10] For a full discussion of the present situation and data bearing thereon, see *Bulletin No.* 4, pp. 5–7 inc., and pp. 35–38 inc.

For recommendations of the Committee on Teaching Personnel in the matter of compensation, see *Bulletin No.* 4, pp. 21–27 inc.

[11] For present teaching loads, see *Bulletin No.* 4, pp. 7–12 inc., and pp. 38–42 inc.

For recommendations of the Committee on Teaching Personnel in the matter of teaching loads, see *Bulletin No.* 4, pp. 19–21 inc.

VII. THE SCOPE OF ENGINEERING EDUCATION

There are two quite distinct types of social needs to be considered in determining the proper scope of engineering education. One approach to the problem is from the relatively impersonal side of the types and grades of engineering services required by society; the other is from the more personal side of the types and grades of preparation needed by various groups of young men. The two approaches are not antagonistic, but there are numerous points at which the two need to be reconciled.

Types of Engineering Activity.—The recruitment and training of men for all grades of engineering activity, vocational as well as professional, call for an educational program of wider and more varied range than can be provided efficiently in a single type of institution.[1] In facing the question of what part of the entire field should be the special concern of the engineering college and what other types of institutions and courses are needed, the Board has envisaged the following types and grades of activities as falling within the engineering field, broadly conceived:

1. Engineering activities of an expert character; concerned with planning, designing, research, establishing methods, the examination of projects, and the like; commonly involving an individual or semi-individual "professional" status; and conveniently designated as "professional practice." Examples:

   a. Private and consulting practice;
   b. Federal, state and municipal professional service; *e.g.*, Engineer of the Coast and Geodetic Survey, Engineer of the State Board of Health, etc.;
   c. Teaching and research in educational and research institutions;
   d. Industrial service in a *staff* capacity concerned with *methods,* as distinct from a *line* capacity concerned with *execution; e.g.,* Designing Engineer, Research Engineer, Rate Engineer, etc.

2. Major administrative activities involving the application of engineering methods and requiring a background of technical knowledge, as well as executive ability of a more general order. Examples:

a. Major executive of an engineering industry; *e.g.*, President, Vice-President, Chief Engineer, General Manager, etc.;
b. Functional executive in a line capacity relating to production, purchasing, plant, personnel, sales, accounts, finance, and the like; *e.g.*, Manager, Superintendent, etc.;
c. Public administrative service; *e.g.*, City Manager, Highway Commissioner, etc.;
d. Private business proprietorship; *e.g.*, Jobber, Contractor, Manufacturer, etc.

3. Technical service in an auxiliary capacity; *e.g.*, Instrument Man, Draftsman, Specification Editor, Laboratory Assistant, etc.

4. Administrative service in a secondary line capacity; *e.g.*, Minor Executive, Foreman, etc.

5. Commercial service in a secondary capacity; *e.g.*, Purchasing Agent, Sales Representative, etc.

Types of Educational Service.—Limiting our consideration to graduates of secondary schools who desire preparation for activities in the engineering field, as outlined above, the Board recognizes that the following types and grades of educational service should be provided:

1. For secondary school graduates intending to devote for a period their principal efforts to further education:

a. A complete college program directed principally to a thorough grounding in the underlying sciences, the principles and methods of engineering, and the related language processes, and to the foundations of humanistic culture;
b. An extended college program in arts and sciences so coordinated with the requirements of engineering col-

leges that the student may transfer to the latter on advantageous terms;

c. A junior college program preparatory to the upper years of the engineering college;[2]

d. A junior college program of technical character, suitable as a terminal program;[2]

e. A thorough and intensive program of technical training, briefer, less theoretical and more specialized than the curriculum of an engineering college.

2. For secondary school graduates who are permanently employed:[3]

a. Part-time day continuation schools under the auspices of the public, the industries, or welfare organizations;

b. Evening technical schools devoted to intensive and specialized instruction;

c. A program of extension education by correspondence, principally of advanced vocational grade.

3. For permanently employed graduates of arts colleges and junior colleges and for non-graduate former students of engineering colleges:[3]

a. A program of evening studies of college grade, affording a connected development of the principles of engineering, together with collateral subjects;

b. A program of evening studies of advanced vocational grade;

c. A program of extension education by correspondence, both of college grade and advanced vocational grade.

4. For graduates of engineering colleges:[4]

a. A program of graduate work in residence, directed to more extended fundamental training and to preparation for engineering specialties of the advanced analytical type;

b. A program of resident college work concerned with the principles of administration, to supplement undergraduate courses in engineering;

c. Programs of experience and training designed to afford an orientation to particular fields of industry;
d. Programs of advanced and specialized training for particular divisions of engineering practice and industry, designed for graduates who have gained initial experience, become oriented to a definite field of effort and are beginning to assume professional responsibility;
e. A program to keep mature engineers abreast of progress and to introduce them, as needed, to advanced technical developments.[5]

It is plain that engineering is not a single grade or type of professional activity;[6] that there is no clearly defined threshold stage which separates the professional status of engineering for auxiliary vocational activities; and that engineering education should not be based on a single, idealized scheme of professional preparation, to which all schools are to be urged to conform as closely as practicable. In this respect engineering education differs radically from education for the professions of law, medicine and dentistry. In consequence methods of up-grading through imposed standardization which have been conspicuously effective in these fields are largely inapplicable to engineering education.[7]

The views of the Board as to the proper scope and character of engineering education are embodied in the following propositions:

A. Objectives.

1. The original dominating motive of engineering education was preparation for the higher forms of expert services detailed in the foregoing outline. Henceforth preparation for the higher administrative services of engineering should take coordinate rank. It should be recognized, however, that the usual path of progress of the engineering graduate begins with subordinate technical activities.[8]

2. The same general grounding is desirable for both the technical and the administrative activities in the engineering field, since the qualities of mind and habits of thought which

are the most distinctive characteristics of the engineer are of more consequence in both realms than a book knowledge of either type of technique.[8]

3. Distinctive training for both the technical and the administrative types of engineering activity should be provided, but only after an adequate grounding in science and engineering fundamentals has been laid. There should be relatively little differentiation of the two types of training in undergraduate engineering curricula.[8]

4. The auxiliary technical services and the minor supervisory and commercial activities associated with engineering are not recruited most effectively from the by-products of a program of professional training, nor are they adequately filled by using them as training assignments for men to be advanced rapidly to the higher types of engineering responsibility. These activities should be included in the objectives of a distinct, non-collegiate type of technical education, briefer, more intensive and more specialized than the programs of the engineering colleges.

B. Types of Educational Programs Needed.

1. Secondary school graduates who are qualified to profit by an extended fundamental preparation and who purpose definitely to enter the field of engineering are best served, in general, by a distinctive program of college work which includes as integral features:[9]

a. An introduction to mathematics and the physical sciences planned with reference to engineering needs and taught in connection with concrete applications;
b. An introduction to the forms of language, verbal, graphic and symbolic, which are used for the communication of facts and ideas in the realm of engineering;
c. An introduction to the social sciences, particularly economics, as related to engineering activity;
d. Appropriate elements of liberal culture;
e. An effective try-out of engineering aptitude and interest and an inculcation of engineering methods and points of view.

2. Secondary school graduates who purpose definitely to enter the technical, supervisory and commercial activities auxiliary to engineering, and who desire a specialized technical training rather than an extended fundamental grounding, are best served, in general, by a course in a technical institute or corporation school of non-collegiate type, or in a junior college organized on similar lines.

3. It is desirable that students of the type referred to in (2) above should be directed to non-collegiate technical schools wherever these are available, rather than to engineering colleges. In regions where technical institutes do not exist and where the junior colleges are not equipped to meet the need, it may be the duty of the engineering colleges to provide an intermediate technical training, either by special short curricula or by a suitably arranged introductory stage of the regular curriculum.[9]

4. Irrespective of the length of the program, the distinctive training for administrative activities which is included in engineering curricula should be:

a. Complementary and not alternative to an extended grounding in sciences and engineering principles;
b. An option which follows rather than one which parallels the introductory engineering program.[10]

5. The present agencies and programs of engineering education fail to supply an adequate recruitment for the line or operating direction of industry, as distinct from its expert staff activities. Training for line duties requires an extended practical training gained through actual performance in industry, as well as sound educational grounding, and comparatively few men are disposed to seek such a training after graduation. The cooperative type of program has given indications of unique merit as a means of meeting this need.

C. Facilities and Standards.

1. The present group of colleges offering work for degrees in engineering is adequate numerically and sufficiently well

distributed relative to population and engineering activities to meet all present requirements for the recruitment of engineering services of professional grade.[11]

2. Present facilities for the non-collegiate type of technical education are wholly inadequate for the proper recruitment of the auxiliary technical, supervisory and commercial activities associated with engineering.[11]

3. A curriculum organized on the cooperative plan, so as to combine high grade educational facilities with industrial experience which is systematically administered and subordinated to educational aims, is an acceptable alternative to the usual college program and affords in addition an adjustment of the student to the requirements of industry such as ordinarily follows after graduation. The adoption of the cooperative plan as a means of covering deficiencies of educational organization and facilities is deprecated.[12]

4. The educational standards of the present group of engineering colleges taken collectively compare favorably with those of all other equally comprehensive groups of undergraduate colleges. This statement holds for the adequacy of their physical facilities, the number and qualifications of their teachers, the level of their admission requirements, the content and rigor of their curricula, the soundness of their scholastic standards, the extent and quality of their research activities, and their expenditures per student.[13]

5. Disregarding all external comparisons and considering only variations within the group of colleges conferring degrees in engineering, approximately one-third of their number fall below a satisfactory standard in one or more of the above-named particulars. Institutions having such deficiencies should consider the alternative of up-grading their standards or of accepting a less ambitious status.[14]

6. In view of the present abundance of facilities for engineering education of collegiate type and the relative dearth of facilities for vocational and technical education of a shorter and more intensive type, further multiplication of engineering colleges should be discouraged for the present unless the

accessions to the group are of exceptional strength. (It is disconcerting to note that most of the recent additions to the group of colleges granting degrees in engineering have had their origins under circumstances which do not afford an adequate guarantee of educational standards, being established as part of a local enterprise of educational promotion, under ecclesiastical and welfare organizations, or as purely commercial undertakings.)

7. The influence at the command of the engineering colleges and the professional societies of engineers should be employed to direct new entrants to the realm of technological education into the now inadequately filled fields of the technical institutes and the vocational schools. To this end the engineering colleges should lend their assistance and counsel in shaping suitable programs for other types of technical schools and in giving their work a recognized educational status.

D. Undergraduate Status.

1. In general it is desirable that engineering colleges should preserve their full undergraduate status. There are valid objections to the segregation of the instruction in mathematics, sciences and languages from the engineering curriculum and from the control of the engineering college, though there are also objections to the teaching of these subjects solely from the standpoint of their narrower application as tools in engineering.[15] The division of the entire program into two parts, the first consisting of pre-engineering studies to be pursued in a college of arts and sciences, and the second consisting solely of the professional work in the engineering college, may be advantageous under exceptional circumstances but is not recommended as a general practice.

2. In general pre-engineering study in a college of arts should be voluntary rather than required, but this practice is to be commended when the student has the inclination and resources, seeks a wider range of intellectual and social contacts and wishes to defer his final decision with regard to entering engineering.[16]

3. It is desirable, however, that there should be a larger measure of recruitment of engineering colleges from arts colleges of highest standing. To this end it is desirable that there should be a closer coordination between the curricula of the two types of institutions, that the terms of admission to advanced standing in engineering colleges should be set forth as explicitly as possible, and that these terms should be as favorable to the graduates and upper-classmen of arts courses as reasonable safeguards will allow.[17]

E. Further Training of Graduates.

1. It is desirable that resident graduate work for advanced degrees should be undertaken only by engineering colleges with notable teachers and exceptional facilities; that a program of additional undergraduate studies should not be considered as graduate work leading to an advanced degree; that the several institutions engaged in graduate work should emphasize distinctive fields of effort according to their special advantages of personnel, location and equipment; that the graduate student should seek out the best qualified master in his field of special interest and, in most instances, should migrate to some institution other than the one attended as an undergraduate for the sake of the added breadth; and that financial inducements to prospective graduate students should be offered only to men of distinct promise.[4]

2. Programs of introductory experience in industry designed to serve as a process of orientation for engineering graduates meet a recognized need and deserve to be extended more widely. The aims and results of such programs, however, should not be confused with the ends sought in advanced formal training for the specialized fields of engineering practice.

3. Specialized training, other than that normally provided through the variety of quite general curricula devoted to a grounding in engineering principles and methods, properly belongs to the years after graduation. Effective training for

many of the fields of individual effort in engineering can not be given efficiently in most cases before the graduate has gained sufficient experience to afford him a trial of his interests and powers and to lead him to an intelligent choice of a field of specialization. A minority of graduates may be expected to extend their formal training continuously, or after a short break, through resident graduate work.[4] It can not be assumed, however, that the majority of young engineers will normally be led to return to college as full-time students in pursuit of more advanced and specialized training. It is, therefore, necessary to provide much more fully than at present for the post-scholastic extension of engineering education of advanced character.

REFERENCES

[1] For a further discussion, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, pp. 24–26 inc.

[2] *Ibid.*, pp. 27–30 inc.

[3] For provisions now made by engineering colleges for these types of educational programs, see report of Committee on Services, Facilities and Costs, *Bulletin No.* 5, pp. 6–8 inc., and 18–21 inc.

[4] *Ibid.*, pp. 4–6 inc., and 15–17 inc.

[5] As illustrated by the graduate courses offered by the University of Wisconsin for practicing engineers residing in Milwaukee, see "Seminars for Practising Engineers," by Edward Bennett, *Journal of the A. I. E. E.*, October, 1926, pp. 996–998.

[6] For a further discussion, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, p. 24.

[7] *Ibid.*, p. 27.

[8] For opinions regarding the importance of Administration and Management as elements of the engineering curriculum, see *Bulletin No.* 9, pp. 15–17 inc.

[9] For consensus of opinion as to the common content of curricula for *all* engineering students, see *Bulletin No.* 9, pp. 8–12 inc.

[10] For consensus of opinion of prominent members of the engineering profession, see *Bulletin No.* 9, pp. 15–17 inc.

[11] This is supported by an analysis, as yet unpublished, of the ratios of numbers of engineering colleges to white male population in the several states and sections of the country and by other unpublished data bearing on the subject.

[12] For resume of data relating to cooperative engineering courses, see *Preliminary Report of Committee on Cooperative Courses*, presented at the Iowa meeting of the Society, June, 1926. Copies of reprints of the report may be obtained from the office of the Director of Investigation, S. P. E. E., 33 West 39th Street, New York City.

[13] For data on facilities and costs, see *Bulletin No.* 6, pp. 3–6 and 11–15 inc.

For data on admission requirements, see *Bulletin No.* 2, pp. 3–6 and 22–23 inc.

For data on curricula, see "A Study of Engineering Curricula," by Walton C. John, *Journal of Engineering Education*, April and May, 1926.

For data on qualifications of teaching personnel, see *Bulletin No.* 4, pp. 12–13 and 41–43 inc.

For data on research activities, see *Bulletin No.* 5, pp. 2–5 and 10–14 inc.

[14] This statement is based upon a careful analysis of the situation made by the Staff but as yet unpublished.

[15] For a further discussion, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, pp. 27–29 inc.

[16] For recommendations relating to the admission of such students, see Section III, "Admissions," of this report.

[17] For further consideration of this matter, see Preliminary Report of the Director, *Journal of Engineering Education*, September, 1926, p. 30.

A SUMMARY OF OPINIONS CONCERNING ENGINEERING CURRICULA *

Purposes.—The chief purpose of the present investigation of engineering education was stated at the time of its inception in the following sentence: "It is therefore proposed that the investigations of this Society be directed to a study of the objects of engineering education and the fitness of the present-day curriculum for preparing the student for his profession." In accordance with this purpose one division of the investigation has been devoted to studies of the engineering curriculum. Two groups of such studies have been made, one dealing with the content and arrangement of present-day curricula and the evolutionary changes through which they have reached their present form, and the other with the opinions of those most directly concerned as to the fitness of the curriculum for preparing the student for his profession.

Collateral Studies.—The study of the content and arrangement of engineering curricula has been carried out through the generous cooperation of the United States Bureau of Education. The results are given in Bulletin No. 10 of this series. The study of evolutionary changes in curricula has been made by the Staff, as named elsewhere, and recorded in Bulletin No. 11. Opinions regarding the curriculum have been gathered from three groups of individuals: Engineering graduates of institutions throughout the United States and Canada, influential members of the principal national engineering societies, and engineering teachers. These three groups will be referred to hereafter as "graduates," "engineers," and "teachers," respectively. Compilations of the opinions of graduates will be found in Bulletin No. 3; those of the engineers in Bulletin No. 12. The present bulletin deals primarily with the opinions of the teachers, but also includes comparisons of their opinions with those of the other groups.

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Sources and Methods.—The questionnaire through which opinions of the teachers were obtained was prepared by the Staff and circulated through the cooperation of faculty committees in 137 institutions. Replies were received from 534 teachers in 115 institutions, a return of approximately sixty-seven per cent. An effort was made to obtain opinions chiefly from the more experienced teachers. It will be observed from the tabulations on pages 380 and 381 that this was accomplished. It will also be noted that teachers of engineering subjects predominate among those who furnished opinions, although there is a representation of teachers of other subjects. In all cases individual opinions were requested. In the collateral studies, 6,269 graduates and 855 engineers expressed themselves, returns of approximately forty and fifty-five per cent respectively. The compilation of replies and preparation of the summaries which follow were made by the Staff.

In order to facilitate the systematic compilation of replies, the questionnaire form was arranged so that answers could be given by entering check marks opposite appropriate items. Blank spaces were also provided in which additional statements of opinion could be entered. A great many of those who replied availed themselves of this opportunity to express themselves in their own words. These spontaneous comments not only furnish indices of the reasons underlying the opinions held, but also add thoughts which the formal answers do not bring out.

The material is presented in two groups: Part I is a general presentation and discussion of the results; and Part II, a numerical summary of the replies from teachers.

PART I. DISCUSSION OF OPINIONS

A. Diversity of Curricula

Past and Present Tendencies.—The extent to which curricula in the major divisions of engineering (civil, electrical, mechanical, etc.) should be differentiated from each other is an important problem in engineering education. In general the

present tendency seems to be toward less distinct differentiation than was the case two or three decades ago. Students enrolled in the several curricula now pursue identical programs for the first year in most institutions. In more than one-fourth of the colleges the common program extends through two years and in a few cases through three years. Even after differentiation begins many subjects are common to all curricula.

Extent of Differentiation Favored.—The purpose of the question on this topic was to obtain a concensus of opinion as to how far this differentiation should be carried. Teachers and engineers were requested to indicate whether they believed curricula should be *sharply* differentiated; *moderately* differentiated, or only so as to assure concentration on a logically related group of technical subjects; or *slightly* differentiated, so as to give a broad, general engineering training. It will be observed from Fig. 1 that the concensus of opinion of the teachers is clearly in favor of a moderate degree of differentiation, five-eighths of the replies indicating that view. A considerably smaller proportion, about one-fourth, favor a slight degree of differentiation, while only about five per cent favor a sharp degree of differentiation. Less than five per cent of the teachers were non-committal. These opinions are summarized in detail on page 382 of Part II. Preferences of the engineers are about equally divided between slight and moderate degrees of differentiation. Both groups clearly believe that sharp differentiation of curricula is undesirable. If the opinions of the two groups are pooled, a moderate degree of differentiation is favored.

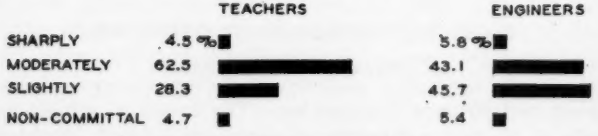


FIG. 1. Preference of teachers and engineers as to the degree of differentiation between the principal engineering curricula. (Percentage of teachers who indicated each item is shown.)

Two thoughts are frequently expressed by the engineers in their spontaneous comments on this topic: One the belief, apparently based on general grounds, that a broad training is the best preparation for the present-day needs of the engineer; and the other that college students are seldom able to predict the lines which their future endeavors will take and consequently should not be obliged to follow a program designed to fit them for some particular field. Several of the engineers cite their personal experiences as the basis for this view.

Comments of the teachers indicate that while they do not disagree with either of these opinions they feel that a moderate degree of differentiation is desirable because it affords concentration upon a logically related body of engineering material instead of a scattering over a wide range of subjects bearing little or no relationship to each other, and because such concentration serves to arouse and maintain the student's interest in his work.

Use of the Term Specialization.—The term "specialization," as used in connection with engineering education is often applied to the subject of the preceding paragraphs, namely, the differentiation of instruction in accordance with the major divisions of engineering—civil, electrical, mechanical, etc. In the present discussion, however, it is used in a narrower sense and applied to the further degree of differentiation of curricula and instruction within the major fields themselves, such, for example, as the provision of distinct curricula in sanitary engineering, structural engineering and the like within the major field of civil engineering.

How Much Specialization is Warranted?—The extent to which such subdivison of curricula should be carried and the provision which should be made for preparing students to follow particular lines of engineering work is a much discussed problem. Three specific questions relating to it were submitted to the teachers: (1) whether or not engineering colleges should offer specialized undergraduate curricula in subdivisions of the major fields of engineering such as those mentioned above; (2) if so, whether such curricula should be offered by all, many, or few institutions; and (3) whether

instruction in subjects applying primarily to one field of engineering only should serve to prepare for particular lines of work or whether it should serve primarily as means of teaching fundamental principles and engineering methods. Slightly more than half of the teachers who replied to the first question indicated that they favor the provision of curricula of the type described, but considerably more than half expressed the belief that such provision should be made in a few institutions only. There was nearly unanimous agreement in the opinion that the primary purpose of instruction in "specialized" engineering subjects should be to teach fundamental principles and methods rather than to train for particular kinds of work. Opinions of the engineers are in agreement with these views. The division of opinions of the teachers on these questions is given in tabular form on pages 382 and 383 of Part II and is shown graphically by Fig. 2.

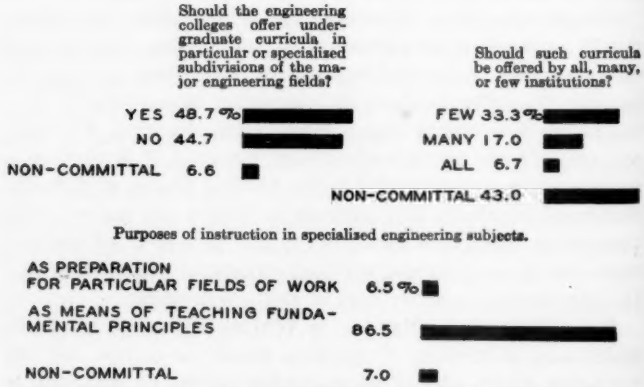

Should the engineering colleges offer undergraduate curricula in particular or specialized subdivisions of the major engineering fields?
YES 48.7%
NO 44.7
NON-COMMITTAL 6.6
Should such curricula be offered by all, many, or few institutions?
FEW 33.3%
MANY 17.0
ALL 6.7
NON-COMMITTAL 43.0
Purposes of instruction in specialized engineering subjects.
AS PREPARATION FOR PARTICULAR FIELDS OF WORK 6.5%
AS MEANS OF TEACHING FUNDAMENTAL PRINCIPLES 86.5
NON-COMMITTAL 7.0

FIG. 2. Opinions of teachers as to specialization in engineering curricula.

Limitations of Specialization.—A large majority of both the teachers and the engineers availed themselves of the opportunity to express opinions on the topic of "specialization" in their own words. Apparently many hold strong beliefs on the subject. The thought most often expressed and strongly

emphasized, particularly by the engineers, is that specialization is out of place in undergraduate curricula and that thorough grounding in fundamentals is of paramount importance. This belief, however, appears to be coupled with the thought that opportunity to pursue special lines of engineering study should be available, but only in the larger institutions or those specially equipped and manned to offer the work properly, and only then as graduate courses, or at most as options in the senior year. These views are expressed so frequently and in such forcible language as to indicate a strong majority conviction. The suggestion is also made that specialized courses should be offered in certain institutions in accordance with local conditions or needs. Several speak of the advantage of concentration by certain institutions on particular curricula and state that agreement should be reached by the colleges as to a proper division of the engineering field. They recognize, however, that it would be very difficult to make any apportionment of curricula among institutions in this manner. Many of the teachers express the belief that in teaching "specialized" engineering subjects there is no essential conflict between preparation for particular fields of work and training in fundamental principles and methods, although the latter should always be the primary purpose. If any one statement could adequately summarize the great number and diversity of opinions expressed it would probably be that specialization has a legitimate and necessary place in engineering education but that it should be confined to post-graduate courses and to those institutions which are qualified to offer the work as genuine professional study of high grade.

Suggested Functional Group of Curricula.—In the preceding paragraphs, differentiation and specialization have been discussed from the standpoint of the usual practice of providing curricula corresponding to the technical divisions of engineering. An entirely different type of classification may, however, be applied to the various kinds of engineering activity in accordance with their *functional* aspects, i.e., research, design, supervision, sales, etc. During the past few

years the question has been raised as to whether or not the accepted and historic types of curricula properly satisfy the demand for men qualified for these functional types of service. Those who raise the question ask, for example, whether engineering graduates have been as well prepared for service in industry by curricula which differentiate between mechanical engineering and electrical engineering as they would have been by curricula which distinguish primarily between the engineering of design and the engineering of supervision. These questions were discussed and a proposed plan of curricula organized on functional lines was presented in a paper by Professor Edward Bennett which will be found in ENGINEERING EDUCATION for June, 1924. Without presenting a complete statement of the proposal or entering into any discussion of its merits, it may be said that the plan comprises two essential features: One is the provision of two grades of treatment, profoundly technical and moderately technical, for the fundamental subjects of the early years of the curriculum; and the other, the provision in the upper years of more extended and rigorous treatment of technical subjects for some students, and of less extended treatment of those subjects in combination with a wider range of commercial and non-technical subjects for others.

The introduction of such a plan would entail far-reaching changes of methods and organization. Advocates of the plan point out, however, that it would not only accord more nearly with the various functional activities of engineers but also with the differing abilities and inclinations of students.

Opinions on Functional Plan.—Questions relating to this matter were submitted to both engineers and teachers who were asked to state first, whether, in their opinion, there is merit in the principle upon which the plan is based, and second, whether or not it is worthy of a trial in one or more institutions. In their replies slightly more than half of the teachers expressed the belief that the principle upon which the plan is based has merit while approximately one-fourth believe that it has not. The balance were non-committal. Approximately one-half feel that the plan should be tried in one or

more institutions; about eleven per cent feel that no trial is warranted. About forty per cent were non-committal. These opinions are summarized in greater detail on page 383. The engineers were somewhat less favorable both to the principle upon which the plan is based and to its proposed trial.

Replies of both groups are shown graphically in Fig. 3.

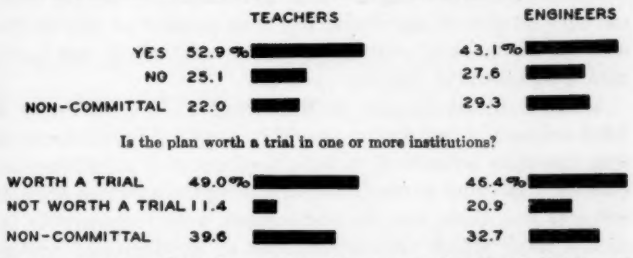


FIG. 3. Opinions of teachers and engineers as to functional division of curricula.

Comments on Functional Plan.—The general tone of the comments on the proposed plan of functional division of curricula is one of endorsement of the principle but skepticism as to its practicability. A number of teachers ask how the students are to be separated into the groups contemplated. Several feel that no valid means of separation are available and question whether any can be devised. Many, while frankly skeptical of the plan's practicability, would like to see it given a thorough trial. They state, however, that it could not be tried in their own institutions. One or two fear that the proposed moderately technical treatment of fundamental subjects might become superficial and thus have no value as a part of the training of an engineer.

B. Subjects Which Should Be Included in All Curricula

The Swing Toward Fundamentals.—Of late years there has been a gradually increasing tendency in engineering education to concentrate on fundamental principles and methods

and a corresponding swing away from instruction in the more specialized subjects. It is evident, as noted in a preceding paragraph, that this movement has the endorsement of engineers and teachers alike. It is therefore natural that much thought and discussion should have been devoted to the question of what constitute "fundamentals." Stated explicitly, the question is raised, "What subjects should constitute the common core of the engineering curriculum?" To the present time no general agreement has been reached on this matter and one of the chief purposes of the present study was to obtain a consensus of opinion upon it.

What Subjects Should be Required?—The question as to what subjects of instruction should be required in all curricula was therefore submitted to both teachers and practicing engineers. In order to facilitate answering the question a list of subjects was given and the respondents were requested to indicate those which they considered of fundamental importance. The list of subjects included those which are commonly required of all engineering students irrespective of the curriculum in which they are enrolled and also a considerable number of other subjects regarding which there might be some question. Spaces were also provided in which other subjects could be entered. The teachers were requested to indicate by the figure "1" those subjects which they considered of primary importance and by figure "2" those which they considered of secondary importance. The engineers were merely asked to indicate their selections by checkmarks. The resulting body of opinion, which is based upon the replies of over five hundred teachers of extended experience and more than eight hundred of the leading engineers of the country, is probably a good indication of present opinion on this matter.

The list of subjects indicated by a majority of the teachers as of primary importance is as follows:

Mathematics—through Calculus,
General Physics,
English—Composition and Speech,

Inorganic Chemistry,
General Economics,
Graphics—Mechanical Drawing and Descriptive Geometry,
Mechanics of Materials,
Analytical Mechanics,
Elements of Electrical Engineering,
Hydraulics,
Elements of Thermodynamics,
Surveying.

The practicing engineers indicated all of the foregoing and the following in addition:

Business Law,
Accounting,
Shop Work.

If the opinions of the two groups are pooled, the list is identical with that of the teachers with the single addition of Business Law.

In answer to another question which will be discussed more fully later, both teachers and engineers unmistakably indicated the belief that provision should also be made for cultural or humanistic subjects, though there was no majority agreement upon specific subjects. It may be inferred that opinions favor a rather wide range of cultural electives. It is clear, however, that the engineers and teachers believe that such subjects should be included in the common core of fundamentals.

The subjects selected, as described above, embody the ideas of engineering teachers as to the foundation of engineering curricula. It is evident that the concensus of opinion is in favor of curricula of predominantly scientific and technical content with the addition of an appreciable element of purely cultural subjects. A study of the time commonly alloted to the various subjects indicates that the core of fundamentals constitutes about two-thirds of the entire curriculum. This appears to be in harmony with the opinions previously cited as to the degree of differentiation and specialization deemed proper.

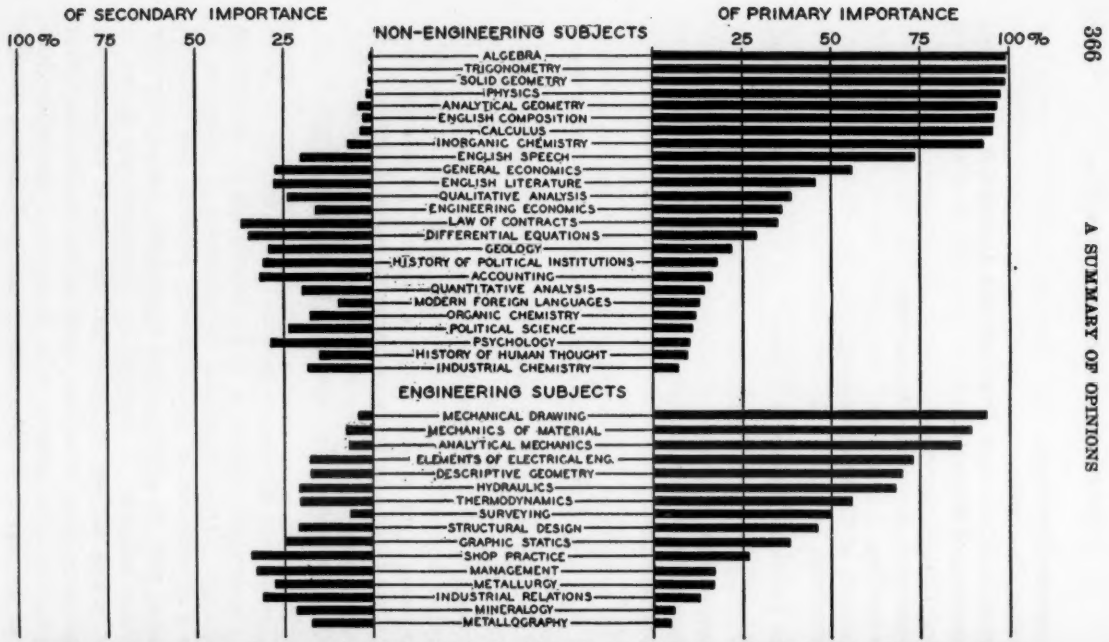


FIG. 4. Opinions of teachers as to subjects which should be included in all curricula in the principal divisions of engineering. (Percentages are based on number of teachers who indicated each subject. See page 384.)

Graphic Tabulation of Opinions.—A complete tabulation of the replies of the teachers to this question is displayed numerically on page 384 and graphically in Fig. 4.

Summary of Comments.—In commenting on the matter of fundamental elements in the engineering curriculum, many of the teachers expressed the view that several subjects not checked would be desirable additions if time permitted, but that the limitations of the four-year course made it undesirable to extend the list. A few teachers believe the curriculum should be lengthened so that the provision can be made for more fundamental subjects. Some feel that certain of the subjects, for example, solid geometry and trigonometry should be required for admission. A few teachers point out that while certain of the subjects, such as thermodynamics, should be required of all students, their treatment should be different for different groups. Some of the teachers add the comment that subjects not checked should be offered as electives, thus providing a proper range of selection for students of different aptitudes and interests.

C. Economic Content of Engineering Curricula

Importance of the Problem.—It has been aptly said that the engineer is a practical economist. Certainly it would be difficult to overestimate the economic importance of his work. To many, however, it appears that this is not reflected by commensurate provision in the curriculum for the economics of engineering. This belief was brought out early in the present investigation by the views expressed by practicing engineers and industrial leaders. Some of these were given in response to inquiries; others were unsolicited, spontaneous expressions. It was therefore decided to pursue the inquiry into this aspect of the curriculum further by submitting certain specific questions to the teachers and engineers.

Present Deficiencies.—The engineers were first asked to state whether, in the light of their experience, recent engineering graduates are as well qualified to deal with the economic aspects of engineering problems as they are to deal with their technical aspects. The same question was then asked as to

FIG. 4. Opinions of teachers as to subjects which should be included in all curricula in the principal divisions of engineering. (Percentages are based on number of teachers who indicated each subject. See page 384.)

the more experienced graduates. In reply, over ninety per cent stated that they find recent graduates not as well qualified to deal with the economic as with the technical phases of their work. Nearly seventy per cent expressed the same view as to graduates of five or more years' experience.

The graduates themselves throw light on this matter. In response to an inquiry, a majority of recent graduates named economics or related business subjects as the most serious omission from their college curricula. A large proportion also stated that they had pursued the study of these subjects after graduation.

Emphasis to be Given.—Teachers and engineers were then asked to state whether, in their opinion, *much, moderate* or *little* emphasis should be given to the economic aspects of engineering in the undergraduate curriculum and to indicate means through which such emphasis could best be provided. In reply, approximately twenty-two per cent of the teachers felt that much emphasis is warranted, approximately sixty-nine per cent felt that moderate emphasis is desirable, while about seven per cent felt that little emphasis is needed. Two per cent were non-committal. The replies of the engineers were distributed as follows: Much—49 per cent, moderate—45 per cent, little—6 per cent.

It is quite clear that the engineers are more strongly in favor of extended training in economics and its application than are the teachers. Two explanations may be offered for this divergence of view: One, that engineers in active practice are more likely to be cognizant of the place which the solution of economic problems has in the engineer's activities; and the other, that the teachers, who are more closely in touch with methods pursued in college, do not believe that more extended courses in economics of the type now given would be valuable or that explicit training in the applied economics of engineering is practicable.

Methods and Means of Instruction.—As to the means through which instruction in economics and its applications to engineering problems should be given, the teachers and engineers were asked to state whether they prefer (1) more

extended courses in general economics (political economy) of the type now generally provided; or (2) the addition of courses in practical economics given from the engineering point of view; or (3) the more general introduction of the economic element in the engineering subjects themselves. In reply to this question about one-fifth of the teachers indicated that more extended courses in general economics should be provided. Slightly more than one-half feel that both the addition of courses in practical economics and the stressing of the aspects of economy in the engineering subjects would be desirable. Approximately ten per cent of the teachers did not answer this question. About one-fourth of the engineers favor additional work in general economics; about the same proportion favor the addition of special courses in practical economics, while over sixty per cent believe that greater emphasis upon economy should be given in the engineering subjects proper. Table VI on page 385 summarizes the opinions of the teachers.

Graphical Summary of Opinions.—A graphical summary of these opinions is given in Fig. 5.

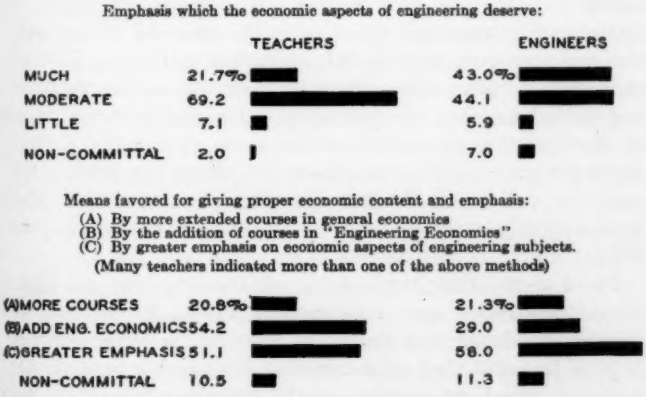


FIG. 5. Opinions of teachers and engineers as to instruction in economics and the economic aspects of engineering.

D. Instruction in Administration and Management

Recognition of the Problem.—In recent years increased attention has been given to the training of engineers for the managerial and administrative duties which they so frequently discharge. This trend in engineering education is shown by the fact that seventeen institutions now offer complete curricula in engineering administration, commercial engineering, industrial engineering, and the like. In addition, administration and management are frequently required as subjects of instruction in other curricula. In a few institutions they are required of all engineering students. The place which instruction in the realm of management should have in engineering education, whether it should be required of all students, whether it should be offered in separate curricula or given as part of others, and similar problems have not, however, been satisfactorily solved; at least there is no general agreement upon them. An effort was therefore made to obtain the concensus of opinion of engineers and teachers upon a few fundamental aspects of this matter.

Should Specific Instruction Be Given?—In answer to the question "Do you believe that all engineering students should receive specific instruction in the realm of administration and management?" slightly more than half of the teachers replied in the affirmative, about three-eighths in the negative, and the balance were non-committal. The replies of engineers to this question showed about the same distribution; fifty-seven per cent being in the affirmative, thirty per cent in the negative, and about thirteen per cent non-committal. The concensus is clearly in favor of specific instruction in this field.

Place in the Program.—As to whether separate curricula in administration and management should be offered or whether these subjects should be required in other courses, it is to be noted that approximately seventy per cent of the group of prominent members of the American Society of Mechanical Engineers to whom the question was submitted expressed the belief that these subjects should be taught as part

of the mechanical engineering curriculum rather than separately. Only fifteen per cent felt that provision of complete, separate curricula is the more desirable plan. The opinions of engineers upon the question of the relative weight to be given to the technical and the administrative phases of engineering in the curriculum is indicated by the fact that a large majority of members of the American Society of Civil Engineers and the American Institute of Electrical Engineers favor predominantly technical courses followed by special business courses for those who wish to pursue them, in preference to predominantly business courses with some engineering work as the normal program. They apparently feel that the engineer is best prepared for his administrative and managerial duties by a thorough grounding in the technical aspects of his work. It is to be noted that a considerable proportion of the members of the three societies who expressed these views are themselves engaged in work which is primarily executive or administrative in nature.

Upon the question of whether administration and management should be included in all, or merely in certain, curricula, a majority of the teachers, as previously stated, expressed the view that such instruction should be required in all courses. Those who felt otherwise were asked to specify the curricula in which these subjects should be included. In reply, the mechanical engineering curriculum was mentioned most frequently, followed by preference for an optional provision in all curricula, and by electrical engineering as a third choice.

A detailed summary of the replies to questions on this topic will be found in Part II, page 385.

Summary of Comments.—Although a majority of the teachers who replied to questions relating to administration and management felt that instruction in these subjects should be given to all engineering students, those who commented on the matter were inclined to point out objections. The thought most often reiterated was that work of this character should be left either to post-graduate years in college or to independent study after graduation. A few took the position that these subjects are not sufficiently concrete to warrant inclusion

in an already crowded curriculum at the expense of technical and scientific subjects which, in their opinion, are susceptible of more definite treatment. Quite a number felt that while instruction in administration and management should be required in certain curricula, generally those relating most closely to the manufacturing industries, all students should not be required to pursue such courses. The comments of both teachers and engineers reflect the condition previously mentioned; namely, that there is no general agreement on these matters and that the institutions are attacking the problem by different methods and from divergent standpoints.

E. Cultural Subjects

Use of the Word "Cultural."—The word "cultural," as applied to subjects of the engineering curriculum, is very generally used to designate the group of non-professional, humanistic subjects which includes English literature, history, economics, foreign languages, and the like. It by no means follows that the engineering subjects themselves lack cultural value; in fact, the teaching of science or engineering may be, and often is, more liberalizing than routine drill in some of the so-called "cultural" subjects. The term has, nevertheless, come to have the general usage mentioned and it was felt that its application would be understood by those to whom questions relating to this portion of the curriculum were submitted.

Importance in the Curriculum.—That cultural subjects should constitute a prescribed part of the curriculum seems to be generally accepted as a fundamental principle. At the present time approximately nineteen per cent of the required subjects of the engineering curriculum fall within this class, this being the average for institutions in the United States. Endorsement of the principle is clearly given by the answers of teachers to a question as to whether subjects of purely cultural value should be required of all engineering students, since approximately two-thirds replied in the affirmative and only about one-fifth in the negative, the balance being noncommittal.

As to the extent of provision which should be made for these studies, about one-eighth of the replies indicated that they should be given considerable emphasis and an important place in the curriculum, about one-half that moderate emphasis and time should be devoted to them, and only about one-sixth that they should be given a place of minor importance. Graduates hold much the same view, all but about fourteen per cent stating that, in their opinion, cultural subjects are of sufficient value to warrant their inclusion. Approximately fifty-seven per cent rate them as of "considerable" or "great" importance, while over one-fourth indicate the belief that they are "indispensable to their intellectual development."

Choice and Distribution.—If cultural subjects are to be given an important place in the curriculum, the questions naturally arise: How shall these subjects be distributed throughout the four years, and what particular subjects shall be offered? In answer to the first of these questions, approximately sixty per cent of the teachers expressed the belief that cultural subjects should be offered or required throughout all four years instead of during the first two years only, as was the almost universal custom until quite recently and is still a common practice.

In answer to the second question, the teachers named a considerable number and variety of cultural subjects; literature, history, economics, modern foreign languages, philosophy, and political science being mentioned most frequently. Only literature, however, was favored by a majority.

Fig. 6 shows the replies to the above questions graphically.

Comments on Cultural Subjects.—Although space limitations of the questionnaire did not permit discussion of the manner in which the word "cultural" was used, comments of the teachers indicated that there was little or no misunderstanding of the intent. Quite a number, however, objected to this narrow use of the term and stated that all subjects, if properly taught, have cultural value. Comments were decidedly favorable to the requirement of cultural studies. Many of the teachers pointed out that these subjects are likely to be of the greatest value and interest if given in the later

years. Several made the comment that cultural studies should be included to give balance to the curriculum and to provide the student with fields of interest outside of his scientific and technical subjects. Quite a number deplored the fact that the necessity of giving adequate attention to fundamental scientific and technological studies restricted the time available for cultural subjects.

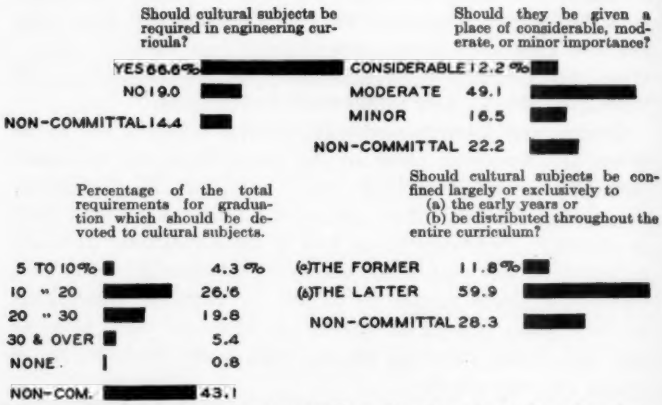

Should cultural subjects be required in engineering curricula?
YES 66.6%
NO 19.0
NON-COMMITTAL 14.4
Should they be given a place of considerable, moderate, or minor importance?
CONSIDERABLE 12.2 %
MODERATE 49.1
MINOR 16.5
NON-COMMITTAL 22.2
Percentage of the total requirements for graduation which should be devoted to cultural subjects.
5 TO 10% 4.3 %
10 " 20 26.6
20 " 30 19.8
30 & OVER 5.4
NONE 0.8
NON-COM. 43.1
Should cultural subjects be confined largely or exclusively to (a) the early years or (b) be distributed throughout the entire curriculum?
(a) THE FORMER 11.8%
(b) THE LATTER 59.9
NON-COMMITTAL 28.3

FIG. 6. Opinions of teachers as to the cultural content of engineering curricula.

Cultural subjects which were mentioned as desirable additions to the list given above show a wide and interesting range: Appreciation of Music, History of Architecture, History of Science, Ethics, Evolution, Comparative Religion, History of Art, and many others. This diversity of preferences is a further indication of the view expressed by many that students should be permitted a considerable range of selection rather than required to pursue a few prescribed subjects.

Modern Foreign Languages.—No other subject or group of subjects of the engineering curriculum has suffered the same attrition in the past fifty years as modern foreign languages. The question of their exclusion or inclusion has not

been finally settled, however, and there are many who deplore the present condition. The matter was therefore submitted to teachers, engineers, and graduates in the hope of obtaining a clear cut expression of views.

Without giving a detailed analysis of the replies, it may be said that a large majority indicated the belief that foreign languages, as now taught, are not of sufficient value either as purely cultural subjects or from the standpoint of their practical or "tool" value to warrant their inclusion in the engineering curriculum.

In the matter of the practical value of language study, the replies of the engineers, when asked to state the extent to which they had used their knowledge of foreign languages in connection with their professional or business activities, are interesting. These replies were distributed as follows:

Much	9.3%
Moderately	22.7
Little	39.0
None	27.6
Unstated	2.4

It should be remembered that these engineers include the more prominent members of the profession who might be expected to find greater use for foreign languages than the majority.

An indication of the view of graduates on this matter is given by the fact that in a list of those subjects which they consider of least value modern foreign languages are named nearly as often as all others combined.

Summary of Views on Foreign Languages.—Fig. 7 summarizes the views of engineering teachers on this matter. For tabular summary, see pages 387, 388 and 389 of Part II.

In their spontaneous comments many teachers who felt that foreign languages should not be *required* indicated the opinion that they should be *offered* as electives. Quite a number felt that engineers should have a knowledge of at least one foreign language but believed that it should be acquired before admission to college. Most of the teachers seem to believe that it is impracticable to provide enough time in a four-year engineering curriculum to teach foreign languages ef-

fectively and that their exclusion, while to be deplored, is necessary unless the course is lengthened.

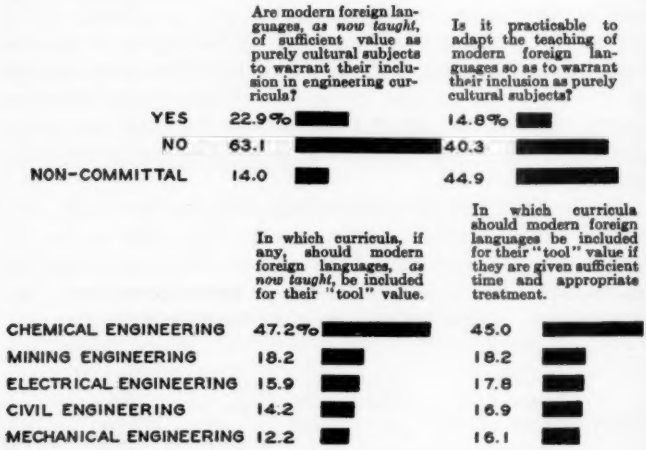

Are modern foreign languages, as now taught, of sufficient value as purely cultural subjects to warrant their inclusion in engineering curricula?
Is it practicable to adapt the teaching of modern foreign languages so as to warrant their inclusion as purely cultural subjects?
YES 22.9% 14.8%
NO 63.1 40.3
NON-COMMITTAL 14.0 44.9
In which curricula, if any, should modern foreign languages, as now taught, be included for their "tool" value.
In which curricula should modern foreign languages be included for their "tool" value if they are given sufficient time and appropriate treatment.
CHEMICAL ENGINEERING 47.2% 45.0
MINING ENGINEERING 18.2 18.2
ELECTRICAL ENGINEERING 15.9 17.8
CIVIL ENGINEERING 14.2 16.9
MECHANICAL ENGINEERING 12.2 16.1

FIG. 7. Opinions of teachers as to modern foreign languages in engineering curricula.

F. SHOP COURSES

Questions Raised.—While probably not one of the major issues in engineering education at present, the general matter of shop courses and certain specific problems relating to them have received considerable discussion. In an effort to obtain some light on these matters, the following questions were submitted to the engineers and teachers:

1. Should shop work be required in all engineering curricula?
2. Should summer employment be substituted for or required in addition to shop work in college?
3. What principal purposes should college instruction in shop work serve?
4. What should be the plan upon which shop courses should be organized and conducted?

Summary of Opinions.—The answers to these questions may be briefly summarized as follows:

1. It is evident that many believe that shop work should not be required of all students, but only of those enrolled in curricula most closely related to the manufacturing industries. Both teachers and engineers are in agreement in this view.

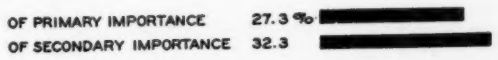


FIG. 8*A*. Opinions of teachers as to the importance of shop courses as fundamental elements in all engineering curricula.

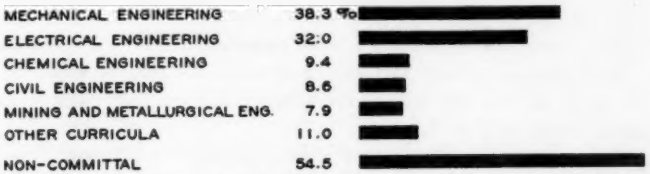
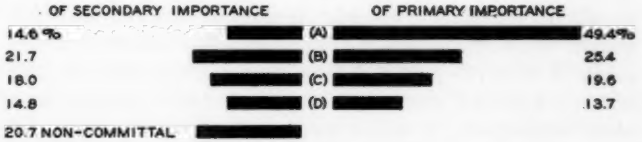


FIG. 8*B*. Opinions as to curricula in which shop courses should be required.



(*A*) Training in the technique of shop operations.
(*B*) Training in the methods of shop management.
(*C*) Imparting of knowledge of the economic phases of shop operations.
(*D*) Development of skill in the handling of tools and machines.

FIG. 8*C*. Opinions as to the primary purposes of shop courses.

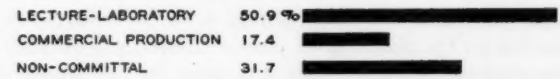


FIG. 8*D*. Opinions as to methods which should be employed in organizing shop courses.

2. It is the majority opinion that summer employment should not be substituted for required shop work in college, though many feel that such employment would serve as a valuable adjunct if properly systematized and administered.

3. Knowledge of the technique of shop operations, and acquaintance with principles of shop management, are regarded as the primary purposes of shop courses, while the development of manual skill and the ability to handle tools and machines is regarded as an entirely subordinate objective.

4. The method of organizing and conducting shop courses on the lecture-laboratory plan as commonly pursued in engineering colleges was preferred to that of an approximation to commercial production methods. Slightly more than one-half of the teachers favored the former, about one-sixth the latter, while about one-third were non-committal.

The replies to these and one or two other questions relating to shop courses are displayed numerically on page 390 and graphically in Fig. 8.

Comments upon the matter of shop courses added very little to the answers to the formal questions. Quite a number of teachers expressed the opinion that shop work had been very much overdone in the past and that the time devoted to it should be materially reduced. A number also felt that there should be a new conception of the purposes of shop work since much of it in the past had been mere manual training without any adequate appreciation of the broader possibilities of shop instruction. It is fair to state, however, that this criticism can not properly be made of the work of many institutions as conducted at present.

G. Coordination of Sciences and Technical Subjects

Is Coordination Needed?—As a final purpose of this study, an effort was made to obtain views on the much discussed problem of the means of obtaining a proper degree of coordination in the teaching of closely related subjects of the engineering curriculum. This was done for the reason that one of the criticisms most frequently made of engineering education is that such coordination is seriously lacking.

In submitting this topic to the teachers, the first effort was to obtain a concensus of opinion upon the principles which should underlie the teaching of the fundamental mathematics and sciences. Specifically, the teachers were asked to state whether, in their opinion, instruction in mathematics and the physical sciences should be based upon the principle that knowledge of those subjects is primarily an end in itself and that preparation for the subsequent engineering subjects, while important, is secondary; or whether instruction in these basic subjects should be upon the principle that they are to serve primarily as tools in the subsequent engineering subjects. The replies indicated that a considerable majority hold the latter view, namely, that preparation for the subsequent dependent engineering subjects should be the primary aim. It must be remembered, however, that there was a large preponderance of teachers of engineering subjects among those who expressed this view. A careful study of the questionnaires, however, showed that a significant fraction of the teachers of mathematics and science agree with the views of the teachers of the engineering subjects proper.

Means of Coordination.—As to means which may be employed to bring about better coordination of instruction in related scientific and technical subjects, the teachers were inclined to recommend that mathematics and the physical sciences be taught either by engineers or by those possessing the engineering point of view and having some familiarity with engineering methods. The introduction of practical engineering problems as illustrations of mathematical and physical laws was also mentioned as a desirable means of promoting coordination. Conferences between the teachers of various departments of instruction and other methods which naturally suggest themselves were also mentioned.

A summary of the replies to these questions will be found in Part II, page 391.

H. Conclusion

Synthesis of Opinions.—In the entire body of opinions cited and analyzed in this bulletin there is discernible a fairly consistent conception of what engineering curricula should be. The more fundamental aspects of this conception may be epitomized by the following characterizations:

1. Moderate diversity, but tending away from specialization;
2. Dominance of scientific and broadly technical content and emphasis;
3. Inclusion of a well-identified core of required subject matter in common;
4. Inclusion at all stages of subjects of purely cultural value;
5. Due emphasis (though not predominant) on the economic aspects of engineering and on its concern with administration and management;
6. Coherence of arrangement and coordination of related subjects;
7. Thoroughness rather than completeness of detail.

PART II. NUMERICAL SUMMARY OF REPLIES BY MEMBERS OF THE ENGINEERING FACULTIES

I. Sources of Replies

Number of institutions from which replies were received	115
Response in per cent of 137 institutions canvassed	84.7
Number of questionnaires received	534
Response in per cent of questionnaires distributed	67.0

Teaching Rank

	No.	%
Professors	381	71.5
Deans	48	9.0
Associate Professors	46	8.6
Assistant Professors	42	7.8
Instructors	9	1.7
Presidents	4	.7
Unstated	4	.7

Years of Teaching Experience

Years	No.	%
1 to 5	33	6.2
6 to 10	88	16.5
11 to 15	94	17.6
16 to 20	106	19.9
21 to 25	78	14.6
26 to 30	53	9.9
31 to 35	28	5.2
36 to 40	16	3.0
Over 40	8	1.5
Unstated	30	5.6

Department or Principal Subject

	No.	%
Civil Engineering	130	24.4
Mechanical Engineering	102	19.1
Electrical Engineering	90	16.9
Chemical Engineering	46	8.6
Mining Engineering	26	4.9
Mathematics	22	4.1
Physics	22	4.1
Mechanics	18	3.8
Drawing	11	2.0
Architectural Engineering	9	1.7
English	7	1.3
Economics	6	1.1
Metallurgy	5	.9
Industrial Engineering	5	.9
Agricultural Engineering	5	.9
Thermodynamics	4	.7
Structural Engineering	4	.7
Ceramics	3	.5
Hydraulics	3	.5
Language	2	.3
Experimental Engineering	2	.3
Highway Engineering	2	.3
Shop Practice	1	.2
Fire Prevention Engineering	1	.2
Petroleum Engineering	1	.2
Sanitary Engineering	1	.2
Aeronautical Engineering	1	.2
Textile Engineering	1	.2
Unstated	5	.9

II. Differentiation of Curricula

1. Replies favoring undergraduate curricula in the major engineering fields which are

	No.	%
Slightly differentiated	151	28.3
Moderately differentiated	334	62.5
Sharply differentiated	24	4.5
Unclassified	9	1.7
Unstated	16	3.0

2. Proportion of curricula common to all of the major branches:

Per Cent	No.	%
20 to 30	3	2.6
30 to 40	7	6.1
40 to 50	10	8.7
50 to 60	40	34.8
60 to 70	28	24.4
70 to 80	15	13.0
80 to 90	9	7.8
Unstated	3	2.6

III. Specialization

1. Should the engineering colleges offer undergraduate curricula in particular or specialized subdivisions of the major engineering fields?

	No.	%
Yes	260	48.7
No	239	44.7
Unclassified	18	3.4
Unstated	17	3.2

2. If so, should such curricula be offered by all, many, or few institutions?

	No.	%
Few	176	33.3
Many	91	17.0
All	36	6.7
Unclassified	195	36.3
Unstated	36	6.7

3. Replies indicating that instruction in specific engineering subjects which apply to a particular field of engineering should be based upon the principle that the aim is to

	No.	%
Prepare men for particular fields of work	35	6.5
Afford means of teaching fundamental principles	462	86.5
Unclassified	24	4.5
Unstated	13	2.5

IV. Functional vs. Technical Divisions of Curricula

1. In your opinion is there merit in the principle upon which the functional plan is based?

	No.	%
Yes	283	52.9
No	134	25.1

2. If so, is it worthy of a serious trial in one or more institutions?

	No.	%
Yes	262	77.1
No	61	18.0
Unclassified	17	4.9

V. Fundamental Elements in All Engineering Curricula

Non-Engineering Subjects	Of Primary Importance.		Of Secondary Importance.	
	No.	%	No.	%
Algebra	526	98.8	1	0.19
Trigonometry	526	98.8	1	0.19
Solid Geometry	523	98.4	10	1.9
Physics	519	97.2	8	1.5
Analytical Geometry	512	96.2	21	3.9
English Composition	510	95.5	13	2.4
Calculus	508	95.4	18	3.3
Inorganic Chemistry	493	92.5	36	6.7
English Speech	392	73.5	112	21.0
General Economics	297	55.7	145	27.2
English Literature	242	45.5	147	27.5
Qualitative Analysis	204	38.3	128	24.0
Engineering Economics	191	35.9	86	16.1
Law of Contracts	185	34.7	196	36.8
Differential Equations	154	29.0	186	35.0
Geology	117	22.0	156	29.2
History of Political Institutions	94	17.6	164	30.7
Accounting	86	16.1	169	31.7
Quantitative Analysis	75	14.0	108	20.1
Modern Foreign Languages	66	12.4	186	34.9
Organic Chemistry	61	11.4	95	17.8
Political Science	57	10.7	127	23.8
Psychology	53	10.0	152	28.5
History of Human Thought	49	9.2	81	15.2
Industrial Chemistry	35	6.5	99	18.5
Engineering Subjects				
Mechanical Drawing	498	93.5	23	4.3
Mechanics of Materials	475	89.0	40	7.5
Analytical Mechanics	458	86.0	33	6.2
Elements of Electrical Engineering	389	72.9	95	17.8
Descriptive Geometry	373	70.0	93	17.4
Hydraulics	360	67.5	111	20.8
Thermodynamics	295	55.5	110	20.6
Surveying	267	50.0	166	31.2
Structural Design	244	45.8	112	21.0
Graphic Statics	202	37.9	133	25.0
Shop Practice	141	26.5	182	34.2
Management	91	17.0	176	33.0
Metallurgy	88	16.5	146	27.3
Industrial Relations	67	12.5	165	31.0
Mineralogy	31	5.8	113	21.2
Metallography	26	4.8	92	17.2

VI. Economic Content of Engineering Curricula

1. The economic aspect of engineering is of such importance as to warrant

	No.	%
Little emphasis	38	7.1
Moderate emphasis	370	69.2
Much emphasis	116	21.7
Unclassified	5	1.0
Unstated	5	1.0

2. The application of economic principles to engineering problems should be given

	No.	%
By more extended courses in general economics	111	20.8
By addition of courses in practical economics	290	54.2
By stressing the economic aspect in the present engineering subjects	273	51.1
Unclassified	2	.4
Unstated	54	10.1

VII. Administration and Management

1. Do you believe that all engineering students should receive specific instruction in the realm of administration and management?

	No.	%
Yes	279	52.2
No	200	37.4
Unclassified	4	.8
Unstated	51	9.6

2. If you believe that such instruction should not be included in all curricula but should be included in certain curricula please name those in which it should be included.

	No.	%
Mechanical Engineering	33	6.2
Electrical Engineering	16	3.0
Industrial Engineering	10	1.9
Chemical Engineering	6	1.2
Civil Engineering	3	.6
Mining and Metallurgy	3	.6
Other curricula	7	1.4
As options in all curricula	20	3.8
In no curricula	7	1.3
Unclassified	57	10.7
Unstated	397	74.1

VIII. Cultural Content of Engineering Curricula

1. Should courses of purely cultural value be required in engineering curricula?

	No.	%
Yes	356	66.6
No	101	19.0
Unclassified	62	11.6
Unstated	15	2.8

2. If so, should they be given a place of considerable, moderate, or minor importance?

	No.	%
Considerable	65	15.4
Moderate	262	62.2
Minor	88	20.9
Unclassified	6	1.4

3. Approximately what percentage of the total requirements for the degree should be devoted to subjects which are primarily of cultural value?

Per Cent	No.	%
5 to 10	23	4.3
10 to 15	92	17.2
15 to 20	50	9.4
20 to 25	62	11.6
25 to 30	44	8.2
30 to 35	14	2.6
Over 35	15	2.8
None	4	.8
Unclassified	32	6.0
Unstated	198	37.1

4. Should cultural subjects be confined largely or exclusively to the early years or should they be distributed throughout the entire curriculum?

	No.	%
The former	63	11.8
The latter	320	59.9
Unclassified	42	7.9
Unstated	109	20.4

5. What subjects would you recommend as particularly valuable or desirable elements of the cultural content of engineering curricula?

	No.	%
Literature	277	52.0
History	246	46.0
Modern Languages	133	24.9
Psychology	109	20.4
Economics	92	17.2
Philosophy	91	17.0
Political Science	86	16.1
Art	43	8.1
Biology	33	6.2
Geology	23	4.3
Others	37	7.1
Unclassified	23	4.3
Unstated	167	31.2

IX. Modern Foreign Languages

1. Are modern foreign languages as now taught of sufficient value as purely cultural subjects to warrant their inclusion in engineering curricula?

	No.	%
Yes	122	22.9
No	337	63.1
Unclassified	17	3.2
Unstated	58	10.8

2. If your answer to the above is "No" please state whether you believe it is practicable so to adapt the teaching of modern foreign languages as to warrant their inclusion in engineering curricula as purely cultural subjects.

	No.	%
Yes	79	25.3
No	215	68.9
Unclassified	18	5.8

3. Please indicate in which, if any, of the following curricula modern foreign languages *as now taught* should be included from the point of view of their practical or "tool" value.

	No.	%
Chemical Engineering:		
Yes	252	47.2
No	35	6.5
Unclassified	13	2.5
Unstated	234	43.8
Mining Engineering:		
Yes	97	18.2
No	87	16.3
Unclassified	12	2.5
Unstated	338	63.2
Electrical Engineering:		
Yes	85	15.9
No	76	14.2
Unclassified	6	1.2
Unstated	367	68.7
Civil Engineering:		
Yes	76	14.2
No	109	20.4
Unclassified	11	2.1
Unstated	338	63.3
Mechanical Engineering:		
Yes	65	12.2
No	110	20.6
Unclassified	7	1.3
Unstated	352	65.9

4. Please indicate in which, if any, of the following curricula modern foreign languages, *if given sufficient time and appropriate treatment,* should be included from the standpoint of their practical or "tool" value.

	No.	%
Chemical Engineering:		
Yes	240	45.0
No	14	2.6
Unclassified	60	11.2
Unstated	220	41.2
Mining Engineering:		
Yes	97	18.2
No	39	7.3
Unclassified	48	9.0
Unstated	350	65.5
Electrical Engineering:		
Yes	95	17.8
No	63	11.8
Unclassified	46	8.6
Unstated	330	61.8
Civil Engineering:		
Yes	90	16.9
No	64	12.0
Unclassified	85	15.9
Unstated	295	55.2
Mechanical Engineering:		
Yes	86	16.1
No	63	11.8
Unclassified	41	7.7
Unstated	344	64.4

X. Shop Courses

1. Curricula in which shop courses should be required:

	No.	%
Mechanical Engineering	205	38.3
Electrical Engineering	171	32.0
Chemical Engineering	50	9.4
Civil Engineering	46	8.6
Mining and Metallurgy	42	7.9
Industrial Engineering	15	2.8
Agricultural Engineering	7	1.3
As an elective	4	.8
Other curricula	9	1.8
Considered uncollegiate	23	4.3
Unclassified	10	1.9
Unstated	282	52.6

2. Summer employment in shops should be required:

	No.	%
In lieu of similar work in college	135	25.3
In addition to similar work in college	142	26.6
Unclassified	30	5.7
Unstated	227	42.4

3. If systematic shop instruction is given to students in college, which of the following should be its purposes?

	Of Primary Importance.		Of Secondary Importance.	
	No.	%	No.	%
Knowledge of the technique of shop operations	264	49.4	78	14.6
Knowledge of the methods of shop management	136	25.4	116	21.7
Knowledge of the economic phases of shop operations	105	19.6	96	18.0
Skill in handling tools and machines	73	13.7	79	14.8

	No.	%
Unclassified	7	1.3
Unstated	104	19.4

4. Which of the following methods should be employed in organizing shop courses?

	No.	%
Lecture-laboratory	272	50.9
Commercial production	93	17.4
Unclassified	17	3.2
Unstated	152	28.5

XI. Coordination of Sciences and Technical Subjects

1. Is it a correct premise to lay down that instruction in mathematics and the physical sciences should be based upon the principle that knowledge of these subjects is primarily an end in itself and that preparation for the subsequent dependent engineering subjects, while important, is secondary?

	No.	%
Yes	95	17.8
No	364	68.2
Unclassified	39	7.3
Unstated	36	6.7

2. Or, should instruction in these subjects be based upon the principle that they are to serve primarily as tools in the subsequent engineering subjects?

	No.	%
Yes	342	64.0
No	69	12.9
Unclassified	30	5.7
Unstated	93	17.4

3. If the latter (No. 2 above) is considered the correct premise, what measures may be taken more closely to coordinate instruction in mathematics and the sciences with the engineering subjects to which they are prerequisite?

	No.	%
Teachers should be engineering graduates or have the engineering viewpoint	178	53.8
Practical engineering problems	68	20.5
Cooperation between departments	53	16.0
Mathematics department should be under the engineering department	18	5.4
Better texts	8	2.4
Grouping of students with similar aims	1	0.3
Unclassified	5	1.5

4. Is there necessity or desirability of limiting the ground covered in these subjects so as to provide for greater thoroughness than at present?

	No.	%
Yes	254	47.5
No	151	28.3
Unclassified	50	9.4
Unstated	79	14.8

ADDRESS OF WELCOME.*

WALTER A. JESSUP, President,

The Iowa State University.

Any educational institution that has an opportunity to serve as host for a day or two during which time the serious and progressive ideas of the craft are to be given consideration can count itself fortunate. The aftermath of such discussions and stimulation serves as a strengthening factor in an institution for months and even years. So it goes without saying that the University of Iowa has a feeling of genuine satisfaction in having the opportunity to serve as host during this convention.

Our faculty has succeeded in impressing the personnel of this University from time to time with the fact that engineering education, in common with other activities in America, is being subjected to scrutiny, to analysis and to the challenges that are common with every other form of human activity.

It is the most gratifying thing about engineering education at the present time that the teachers of engineering education and the professions themselves are to-day concerned, are to-day agitated because of the fact that they are wondering as to whether or not there is a better way. I had occasion yesterday to look into certain facts having to do with the development of education itself. When I dug up the facts of twenty-five years ago—some of you were already teaching at that time—I found there were fewer than 70,000 students in all of the institutions of higher education in America at that time, including academic and all professions. To-day there are around 750,000, an expanse of tenfold within a period of only a partial teaching generation.

Our secondary schools have increased from around three

* Presented at the thirty-fourth annual meeting of the Society for the Promotion of Engineering Education, at the State University of Iowa, Iowa City, June 16–18, 1926.

quarters of a million to 4,000,000 within that same period. Night schools, extension schools, correspondence schools and devices for instruction of every conceivable type have expanded, until some one has happily said that the leading vocation in America is that of a student.

Within this short period of twenty-five years we have witnessed the development of totally new industries and the expansion into gigantic industries of certain infants at the beginning of that period. Twenty-five years ago an automobile was a strange and wondrous device. Our children would not know how to drive it, they would not even know how to get into the inside to sit down in one of those automobiles of twenty-five years ago. In this period we have developed the motion picture, expanded the telephone and developed electrically beyond the dreams of any one of that period. We have developed new processes of manufacture that are truly marvelous.

Some one has said that twenty-five per cent of us are earning our living to-day in ways unknown twenty-five years ago. The greatest compliment that can be paid to the American citizen is the fact that he has been able through the leadership in industry and research to think of all these wondrous things to do, to devise ways of achievement and then to successfully utilize all of this. Mr. Hoover, commenting on this phase of the matter a few days ago, made the statement that in no other country in the world would it have been possible to have sold all of these machines and devices; that no other people in the world could have been trusted with these machines; that no other people in the world could have repaired them and kept them going. In all this discussion of the futility of education and of the danger of educating too many and of the lamentation over the weaklings that are attempting to get an education, to me it was very refreshing to find a member of the cabinet, who is serious minded in this respect, paying a tribute to the wide dissemination of information that has made it possible for us to utilize the things that have come along.

Never in any period in history have we been forced to change

our modes of living as in this last twenty-five years. The invention of practically every machine has meant that somebody has been denied an opportunity to make a living as he made it before. Our old-fashioned mechanics had to become new-fashioned mechanics or they had to become tramps. In other words, in this period of a quarter of a century we have increased our population around 45,000,000; we have moved into the cities; we have built factories; we have taken to ourselves marvelous inventions, and we have refused nothing, irrespective of the cost, irrespective of the apparent difficulty of maintenance and operation that would tend to further the power which we have had or hope to achieve over nature, which to a school master is a source of very great encouragement. We sometimes feel that unless we are turning out a man who is at the top, who has initiative of the highest order, we should be apologetic. As a matter of fact, the engineering schools in this country and their subsidiaries, the great secondary schools, the short technical courses and all, have combined to disseminate information to the most remote hamlet in the land.

What of our future? No one knows, but I for one am optimistic in the belief that we, those of us who are engaged in education, those of us whose task it is to prepare these lads to fit into this complex organization, will be able to do it. We are building upon a marvelous foundation. At the University of Iowa we have been interested in engineering education and the possibilities of combining it with our work in scientific fields, more specially in economics and commerce, to the end that we might be able to help certain students bridge those gaps, but at any rate the feeling that we have here is that we should maintain an open mind and an experimental attitude to the end that we may be able to take these gigantic resources of facilities and men to fit them into this extremely complex picture which we call the world.

I am well aware personally of the activities of a number of your committees, the questions that you are raising. We are very proud of the fact that our own members, our own faculty

men are interested in this and we are verily believing that within a period of a relatively short time there will be real advances in engineering education. Our own Dean Raymond, whose illness at the present moment causes a genuine feeling of gloom and unhappiness, has for his entire teaching life been interested in modifying the technic of engineering instruction. I remember being amazed a few years ago when reading some of the old proceedings of twenty years ago in the debates of this very Society to note Dean Raymond's fearless position in regard to certain debated questions of method. As you know, within recent years he has likewise maintained an aggressive interest in modifying the curriculum, maintaining a faculty that would go in the direction in which he has been traveling for many years.

So without further discussion, in the name of this State Board of Education, and of this faculty, I welcome the Society for the Promotion of Engineering Education to this University; it is yours. We are anxious that you may see the things that we are attempting to do. We are anxious that our faculty may be stimulated by your questions, your criticisms and your challenges, to the end that this session may be a truly great session of this Society.

RESPONSE.

GEORGE B. PEGRAM,

President of the Society.

President Jessup, on behalf of the Society for the Promotion of Engineering Education, I accept this gavel inscribed, "S. P. E. E., University of Iowa, 1926," and I am sure that no Society will ever have or can have its sessions opened more properly than the remaining sessions of the meeting of this Society at the University of Iowa in 1926 will be. I thank you on behalf of the Society.

We are glad to be your guests here in Iowa. No matter how blessed the section from which we come, we can but marvel as we ride from the borders of your state towards this, the center, at the vision of cultivation and fertility that spreads out before us in the great state of Iowa. We are glad to be at the State University of Iowa which, here around the old state Capitol, has grown into one of the very foremost of our great state universities, not only in the number of students that it serves, in the strength of its staff, in the wealth of its buildings and equipment, but even more in its ideals, in its aggressiveness towards new educational standards. To mention only one of those, we are all acquainted with your medical school and the Iowa idea in medical education making of the school of the University a great center for medical service for the greater portion of the state.

Further, we are very glad to be here as guests particularly of the Engineering School of the University of Iowa. We know it not because of its size, but we know it because of the excellence of its faculty, the quality of the graduates that it turns out and the earnest zeal and interest that its faculty shows and has shown for many years in the advancement of engineering education. Particularly do we know well your

Dean, whose illness is the only shadow that comes over us at this meeting. We certainly hope that he will be shortly restored to health and take his revered and honored place among us again.

In the name of the Society, I thank you for your welcome and assure you that we are glad to be at this place for this meeting.

HIGHER EDUCATION AND ENGINEERING EDUCATION.*

BY WALTON C. JOHN,

Assistant Specialist in Higher Education,

U. S. Department of the Interior, Bureau of Education.

Higher education in some form or another since the dawn of civilization has been a vital factor in world building both with respect to ideals as well as matters of sense. This contribution of higher education has varied because of differences in the nature of the physical environment, in the fundamental characteristics of the people, in the theories of government and in the religion or philosophy handed down by leaders of society.

The principal epochs of civilization seem to have evolved along definite lines: first, the period of objective physical growth of the nation combined with an appreciation of personality including a recognition of moral and spiritual values; second, the period of intellectual growth or attainment when educational institutions began to function and which leads to a more critical attitude toward older forms of belief; third, a period of reorganization and application of the existing content of knowledge; fourth, a revolt against intellectualism and materialism with a return to emphasis on the more formal values of life.

The struggle of ancient Oriental civilization for world domination was conditioned by the following factors: a physical nature rather unfavorable to human life, a burning sun, arid lands and deserts, native inhabitants without political rights, conquered inhabitants abject slaves, the government absolute and despotic, a religion that bound the individual through love or fear to the immediate will of the deity.

* Presented at the thirty-fourth annual meeting of the Society for the Promotion of Engineering Education, at the State University of Iowa, Iowa City, June 16–18, 1926.

Education was limited to royalty, nobility and priesthood. The culture was largely literary in character—given to the poetic glorification of the conquering monarch and of the gods that were backing him. The monarch commanded his engineers to build *his* roads, *his* canals, *his* palaces and *his* tombs. All culture and public works centered around the King. This in brief pictures the objective aspect of oriental world building.

Subjectively the Oriental sensed an immediate personal contact with his Deity and he implicitly obeyed his ruler. This sense of submission to higher authority was the outstanding feature of oriental civilization. In its lowest forms it was base and degrading; in its highest forms it reached a superior level from a moral or ethical standpoint. An interesting climax will be recalled in the case of Thothmes the Great, the superb empire builder of Egypt; a scrupulously honest ruler, a death dealer to grafters within, a terror to his enemies without, a promoter of vast building and engineering schemes connected by an excellent highway system well patrolled to the limits of his extended empire. History tells us that as long as he and his successors maintained their moral integrity that this great highway system was adequately maintained and policed. Invaders were kept away from the Egyptian frontiers. But when corruption entered the King's court the patrols were disorganized, highway maintenance failed and before long the outside enemies began to make an end of Egyptian civilization.*

But whatever was taught in the princely library-universities of Egypt or Babylon, in the sacred schools of the prophets of the Hebrews, the outstanding educational contribution of these peoples as far as we are concerned to-day is that of a personal sense of moral responsibility of the individual to his brother or to a higher power. This constitutes the first vital educational principle that concerns higher education of to-day.

The next step in world building is presented by Greece which was endowed by nature with a physical environment much more friendly to man than that of the Orient. Greek geogra-

* Breasted's "History of Egypt."

phy and topography favored strong community differences and thus emphasized the individual who as a citizen participated in local government affairs and who had a personal interest in public works.

But the Greek religion having failed satisfactorily to explain or to justify the many troubles of the early city states the philosopher-scientists tried to find the true reason for these difficulties. From Thales to Aristotle we find groups of physicists, mathematicians, and intellectual theorists challenging theocratic forms of government, oriental ideals, and the religious superstition which accompanied them.

In Greece the human reason reached maximum achievements in literature, in art and architecture, in conceptions of government, in logic and philosophy and in basic concepts of science. These contributions have set the pace for European civilization for 23 centuries.

But aside from all these things the outstanding values given to modern life by the Greeks are the intellectual or rational explanations of the cosmos and an appreciation of the quality which we may designate as intellectual integrity. The latter is the second vital educational principle that concerns higher education of to-day.

But the Greeks, despite their contribution to mental activity were unable on account of their extreme individualism and because of their lack of moral strength, to put in practice their own theories however noble or universal their appeal might be. It took their successors, the Romans, who were the next of the world builders, to introduce the third vital educational principle, which is that of intelligent coöperation, or as we say team work. The ability to organize practical political systems, to organize military forces with a definite goal to be achieved and to manage great public works projects, were the outstanding characteristics of Roman civilization. Sober at first and respectful to their parents and to the gods, the Romans selected ideals of government from the Greek political theorists and achieved world empire. The Roman engineer joined with statesmen and architect-builders in making Rome

the greatest of ancient empires. Conquest without incorporation and individual subjection had been the Oriental ideal, but Rome conquered and incorporated its foes and made them all subject to law rather than to caprice, and also made its inhabitants recipients of many bounties.

But the breakdown of this great world empire may be attributed to the violation of the three cardinal principles that we have just mentioned. The disregard of the Roman youth during the latter period of the empire for parental authority, the abandonment of the recognition the principle of intellectual integrity because of the substitution of the later Greek sophistry and sensationalism that had been imported, and finally, the lack of coöperation between the various factors which maintained the structure of society.

Following the breakdown of the ancient world with all its wealth of religion, of literature, art, buildings, and works of engineering and its fundamental scientific achievements, it was necessary to start all over again on the basis of our first principle. This was done through the Christian Church which struggled within the wreckage of the Roman Empire for over 500 years before it could institutionalize the principle of love and create some semblance of respect for moral authority.

Another 500 years elapsed before the intellectual contributions of ancient Greece were institutionalized in the great medieval universities of Paris, Bologna, Oxford, Cambridge, and shortly after in their offshoots, Harvard, Yale, and Princeton.

This period of university development was of great importance because the universities and other educational agencies were able to take advantage of the disconnected remnants of Greek and Oriental contributions to science, mathematics and logic that had been transmitted through Christian and Mohammedan sources, and to begin the true development of algebra, analytic geometry, calculus, mechanics, physics and chemistry. During long centuries of growing dominance the universities helped to overcome medieval superstition and to develop critical scholarship that has helped to build our modern world.

But however great the Renaissance was in stimulating art and literature, in building great churches and in opening up new avenues of communication, yet for science and the engineer it was a most important period for the incubation of fundamentals in the minds of a few leaders whose mental output was not to become effective until the beginning of the 19th century.

It took another 500 years or more before the idea of the right of the individual to participate in government directly or through representation was finally accepted. This right was challenged by Charles the First in England and the challenge was successfully met by Cromwell when he placed British Parliament on a firm foundation.

This political ideal was then transplanted to the shores of New England, and it combined well with the moral traits and intellectual attitudes of the leaders of early American society.

But notwithstanding the fact that our country in pre-revolutionary times had dominating moral leadership, colleges of high character, and notions of democracy, it was necessary for a new attitude to be taken toward education before our country could begin its phenomenal development. After the smoke of the French and American Revolutions had blown away, the atmosphere cleared sufficiently for men like Franklin and Jefferson to understand the nature of the problems connected with our nation building program.

Before concluding this part of the synthesis it is desirable to recall that from the beginning of the Greek schools down to the present time, there has been a persistent conflict between the content aims and formal aims of education. Time does not permit a detailed discussion of this conflict. It is sufficient however to begin with Lord Bacon and John Milton who began the successful fight against the then dominant narrow, formal, humanistic movement in education that consisted largely in a worship of the form of the classics of Greece and Rome. Following these men Comenius succeeded in outlining a complete program of elementary, secondary, higher and research education which was broad in content and related

itself to the growing environment. But the time for Comenius was not ripe although Harvard University almost obtained him for president.

Reaction against the content aim again appeared under the leadership of John Locke who successfully spread the doctrine of discipline throughout England and later in the American Colonies. But when Franklin, the practical scientist, attacked the classical program of the Academy in Philadelphia, and Thomas Jefferson, a practical statesman, added modern languages and social sciences to the curriculum of the University of Virginia, an educational content was not long in appearing in other colleges and schools that was more fitted for the task of opening up and developing the rich physical and social resources of the United States.

The period from 1800 to 1870 was indeed a critical period for higher education in this country, but despite all opposition the physical sciences gradually established themselves in the colleges, technical institutes and engineering schools and since 1870 the sciences have displaced to a large extent in our high schools the older classical courses of study. In brief from 1870 to 1900 the sciences and mathematics became firmly intrenched in our educational systems.

But since the World War we have entered into a new epoch of education which is dominated by the idea of applied and vocational education.

During the past 20 years and particularly during the last decade there has been an increasing recognition of vocational subjects both in secondary and higher educational schools. This is due to the fact that agricultural development of the country has been transcended by its industrial development as witnessed by the turning of our population to the cities. The world war aided in the recognition of all forms of vocational education and thus our new epoch starts out with the recognition of applied science and applied education on a more or less equal footing with the older academic and scientific subjects.

These facts are shown in a recent study of 182 leading uni-

versities and colleges.* These institutions recognize for entrance requirements as a part of the entrance electives at least 175 definite non-academic or vocational subjects in the fields of commerce, industry, trades, manual training, agriculture, drawing, art, design, home economics, theoretical and applied music, applied English, Bible and surveying. Of these subjects from 2 to 4½ units may be presented as a part of the usual 15 units required. And as the result of the influence of these applied subjects, mathematics has steadily been losing ground as a college entrance as well as a college graduation requirement.

When we consider the fact that average high school curricula include from 60 to 80 courses of which a fair proportion are in vocational fields and that our larger colleges and universities offer dozens of curricula in arts and sciences, in commerce and education, with a total of from 500 to 2,000 or more courses of study many of which are vocational or semi-professional, and if we add our agricultural colleges which train for 70 or 80 professional groups, and if we add the 47 different engineering curricula now offered in our engineering colleges, we shall be in a position to grasp the immensity of the differentiation of educational content and the extent of our program of applied education to a degree far beyond the wildest dreams of the educational content theorists of the past. And this does not include the professions of theology, medicine, dentistry, pharmacy, and law.

Now what does this all signify? It would appear to some that we have reached the time when our civilization has been able to reap the full fruitage of the teachings of the educational theorists of the past. Education is no longer the servant of the despot, the monarchy, the aristocracy, the oligarchy or of the hierarchy. Higher education for 60 years in this country has been less and less the servant of any selected social group, it now serves every individual. The engineer of to-day is not limited to bridges, roads, and power

* "Standards in the Non-Academic Subjects for College Entrance and Graduation," by Frances Moon Butts.

stations, he makes our toast, gives us grand opera, he sweeps our floors, he gives us individual transportation, in a word the modern farmhouse or establishment is an engineering microcosm which contains all of the elements of the many municipal general services which were limited to those in our urban centers. The engineer gives us to-day a thousand individual accommodations.

Now the educational service that has made these benefits possible has become so complex that many of the subjective values which formerly were largely gained through fewer college studies and a more simple environment have been gradually dissipated in the race for the expansion and differentiation of educational content. As a result nearly every type of national leader is calling for a reëmphasis on the general or formal values rather than on specific or professional values. The emphatic call is for young men who are grounded in those fundamentals that we have just mentioned—which civilization has evolved—moral character, intellectual integrity and intelligent coöperation, the elements that make for leadership whether in church, state or industry.

But this reaction in favor of formal values can never go back to the old and fallacious ideas of discipline. Modern psychology and educational theory will save us that.

The critics of to-day are challenging educational subject matter from the standpoint of function rather than from that of its historical status. There is a desire to reconstitute and to simplify subject matter with reference to its immediate effectiveness. This accounts for the project method of teaching, the suggested program of job analysis as basis for engineering curricula and also job analysis for the A.B. degree recently proposed by the American Council on Education. The Antioch plan and the Cincinnati coöperative plan are the result of interest in the immediate effectiveness of the educational process.

On the other hand there are those whose programs indicate that the engineer must first gather the essential principles concerned in our moral, social, and industrial institutions at

the same time they are obtaining a knowledge of general principles of pure and applied science. There are those who would still strengthen this fundamental cultural and scientific base rather than divide the students' energies in the study of additional special topics. This situation is now true for education in the liberal arts and sciences as well as in the agricultural and technical fields. But years of careful experimentation must be the final answer to the validity of the methods and theories suggested, because now we are liable to be influenced in our views by outstanding teachers or students who are a law unto themselves.

In closing we shall now picture the higher educational forces that have been prepared for the building of our civilization as for the year 1923–1924, based upon a report of about 90 per cent of our higher educational institutions and as represented by the number of degrees granted in the various educational fields.

In order of ascendance the degrees are as follows:

First degrees in	Numbers
Veterinary Medicine	95
Fine Arts	182
Forestry	184
Osteopathy	204
Architecture	248
Journalism	360
Music	532
Theology	1,319
Home Economics	1,426
Agriculture	2,327
Pharmacy	2,839
Dentistry	3,356
Medicine	3,642
Education	3,707
Commerce	4,948
Law	6,848
Engineering	6,960
A total number of professional first degrees	39,177
To these we may add	
A total number of graduate degrees	9,261
A total number of liberal arts baccalaureate degrees	38,999
Or a grand total of	87,437

These figures show the importance of engineering in the field of professional education. It stands first in its number of graduates and is followed in order by law, commerce, education and medicine, etc. It approximates three fourths of the total number of graduate students which include teachers and research workers in all fields. The number of engineering graduates are approximately 18 per cent of the number having liberal arts bachelors degree, and a little more than 8 per cent of the total number of graduates of all classes.

But the training of the engineering graduate like those of other educational fields must first rest on the original genius and purposes of the American people. We are told that the characteristics of the Englishman are his sagacity and his sense of fair play and sportsmanship, that the Frenchman is strong in logical analysis and æsthetic appreciation, and that the German is profound and plodding. To what extent the higher educational systems of these foreign nationalities promote these excellent characteristics I cannot say; but there are certain fundamental characteristics of the American people which our higher educational program must seek to perpetuate if we are to have American culture and American engineers.

Optimism, adaptability, a willingness to work and a regard for the highest individual development are some of our cherished characteristics. These are in our original nature.

But higher education must add the vital elements of our intellectual and spiritual inheritance without which we cannot have the vision to comprehend or direct the intellectual and physical forces for the future. Higher education will therefore not minimize language and literature, it will not weaken its regard for the social sciences and pure sciences. An adequate understanding of these fields is now vital for all leaders whether in pulpit, press or in industry. Educational selection will eliminate from leadership those whose grasp or appreciation of inheritance values are weak and give to them the more specific vocational and technical tasks; these are the ones whose education should be for immediate results. In the

future the task will be that of deciding whether any given institution can carry on both types of education, or whether it will decide to render service by preparing large numbers of high grade vocational mechanics or electricians; or on the other hand to sacrifice numbers for the service of preparing engineering leaders who have been trained to comprehend as fully as possible the civilization they help to build.

EXTENSION COURSES IN ENGINEERING.*

Preliminary Report and Condensed Summary of Results

BY C. M. JANSKY.

As part of its contribution to the Society's investigation, the faculty committee of the University of Wisconsin was invited, in view of the long experience of the institution in the field, to undertake a special study of extension courses in engineering. Upon acceptance of the invitation, the study was assigned to a special committee consisting of

Louis E. Reber, Chairman,
R. S. McCaffrey,
A. V. Millar,
H. W. March,
B. G. Elliott,
C. M. Jansky.

The specific objective of the committee was to secure data for evaluating the effectiveness and relative equivalence of extension courses and correspondence instruction to the older and established residence type of engineering instruction. In the pursuit of this object, a questionnaire was prepared and sent to some 2,000 former students of the University of Wisconsin Extension Division. In response 605, or 30 per cent of those addressed filled out the questionnaire.

As two of the specific questions propounded had to do with the relative effectiveness of extension instruction and residence instruction, it is obvious that the answers of only those who had previously or subsequently pursued engineering courses in residence would be of value. The questionnaires were, therefore, classified into five groups as follows:

* Presented at the thirty-fourth annual meeting of the Society for the Promotion of Engineering Education, at the State University of Iowa, June 16–18, 1926.

College and university graduates,
College and university attendants but not graduates,
Normal school, commercial school, academy, and law school attendants and graduates,
High school graduates,
High school attendants and grade school graduates and attendants.

The replies of each of these groups were compiled separately and then in some instances, they were combined. This combination was effected only when the replies were approximately

TABLE I.

RELATIVE EFFECTIVENESS OF EXTENSION WORK IN COMPARISON WITH RESIDENCE WORK.

Replies of University and College Graduates.

Effectiveness as Measured by	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative amount of work per credit	39.7	28.3	7.6	24.4	68.0	52.6	37.4	10	90.0
Mastery of subject	26.7	45.8	12.2	15.3	72.5	31.5	54.1	14.4	85.6
Theoretical knowledge acquired	20.5	42.7	19.5	17.3	63.2	24.6	51.8	23.6	76.4
Practical knowledge acquired	22.5	36.1	19.5	4.8	58.6	28.8	46.2	25.0	75.0
Development of self-reliance	64.4	16.7	3.8	15.1	81.1	75.9	19.7	4.4	95.6
Initiative	63.6	19.0	1.5	15.9	82.6	75.7	22.5	1.8	98.2
Originality	50.8	32.6	22.0	14.4	83.4	59.3	38.1	2.6	97.4
Power of expression	29.5	34.9	14.4	21.2	64.4	37.5	44.2	18.3	81.7

of equal value. Thus in determining the relative effectiveness of residence instruction and extension instruction, the opinions of only those who had some time pursued courses in residence were considered. These opinions are tabulated in Tables I, II, and III.

While an examination of the tables is instructive, the data will have additional significance when it is known that Table I is compiled from the replies of graduates of 82 different

TABLE II.

RELATIVE EFFECTIVENESS OF EXTENSION WORK IN COMPARISON WITH RESIDENCE WORK.

Replies of University and College Attendants.

Effectiveness as Measured by	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative amount of work per credit	46.6	22.7	8	22.7	69.3	60.0	29.4	10.3	89.4
Mastery of subject	39.2	40.4	8.5	11.9	79.6	44.5	45.8	9.7	90.3
Theoretical knowledge acquired	29.0	36.4	18.7	15.9	65.4	34.5	43.2	22.3	77.7
Practical knowledge acquired	37.5	23.9	16.5	22.1	61.4	48.2	30.7	21.2	78.9
Development of self-reliance	75.0	9.1	4.5	11.4	84.1	84.5	10.3	5.2	94.8
Initiative	66.5	18.7	1.7	13.1	85.2	76.5	21.6	1.9	98.1
Originality	59.1	26.1	22.0	12.5	85.2	67.6	29.8	2.6	97.4
Power of expression	30.7	30.1	17.6	21.6	60.8	39.1	38.4	22.5	77.5

TABLE III.

RELATIVE EFFECTIVENESS OF EXTENSION WORK IN COMPARISON WITH RESIDENCE WORK.

Replies of University and College Graduates and Attendants Combined.

Effectiveness as Measured by	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative amount of work per credit	43.7	25.1	7.8	23.4	68.8	57.1	32.7	10.2	89.8
Mastery of subject	33.9	42.7	10.1	13.3	76.6	39.1	49.3	11.6	88.4
Theoretical knowledge acquired	25.2	39.2	19.1	16.5	64.4	30.2	47.0	22.9	74.2
Practical knowledge acquired	31.1	29.1	17.8	22.0	60.2	39.8	37.4	22.8	77.2
Development of self-reliance	70.0	12.4	4.2	13.0	82.4	81.0	14.2	4.8	95.2
Initiative	65.5	18.9	1.6	14.0	84.4	76.0	22.0	2.0	98.0
Originality	55.6	28.9	2.3	13.2	84.5	64.0	33.4	26.0	97.4
Power of expression	30.2	32.0	16.2	21.4	62.2	38.4	41.0	20.6	79.4

TABLE IV.

REASONS FOR TAKING EXTENSION WORK.

Percentages.

	College and University Graduates.	College and University Attendants.	High School Graduates.	Normal School, Commercial School Academy, and Law School Attend's and Grad's.	Grade School Attendants and Graduates and High School Attendants.
At the solicitation of an extension representative	0.5	1.0	0.5	1.9	0.5
Because I realized the need for more extended training	49.5	39.0	56.0	46.0	54.0
At the suggestion of my employer	.0	2.0	4.5	.0	5.0
In preparation for a particular job	2.2	13.5	15.8	7.7	15.0
In preparation for engineering education at a technical school	16.5	15.9	11.3	7.7	10.0
To complete education begun in a technical school	3.2	21.7	4.5	19.5	4.0
In preparation for an advanced degree	12.4	3.4	5.0	11.5	6.6
As a review	7.2	1.0	.6	3.8	1.6
As a supplementary course	5.5	.4	.0	.0	.0
No reply	1.5	.0	.6	.0	.5
In preparation for engineering education at university	1.0	1.0	.0	.0	.0
In preparation for a degree	1.5	.7	.0	1.9	.0
In order to obtain high school units for college entrance	.0	.4	.0	.0	.5
At the suggestion of co-employee	.0	.0	.6	.0	.0
To learn American customs	.0	.0	.6	.0	.5
In order to obtain entrance units to university	.0	.0	.0	.0	1.6

educational institutions, 70 per cent of which are state universities and colleges and independent institutions of equal rank.

Likewise Table II is compiled from the replies of students of 75 different educational institutions, the standing of which is about the same as that of the 82 given above.

As the data of both Tables I and II are valid in determining the equivalence of residence and extension instruction, these data have been combined in Table III.

TABLE V.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of University and College Graduates.

Form of Inquiry.	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	Yes.	No.	No Opinion.			Yes.	No.		
Was the personality of your instructor an influential element in your extension work?	53.4	29.0	17.0			65.4	34.6		
Did he willingly and cheerfully answer all inquiries?	85.0	2.2	12.8			97.4	2.6		
Were his comments accurate and complete?	82.5	3.1	14.4			96.4	3.6		
Were his comments and suggestions stimulating and encouraging to greater efforts?	68.0	11.4	20.6			85.6	14.4		
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative influence of extension teacher and residence teacher	7.6	26.7	36.7	29.0	34.3	10.7	37.7	51.6	48.4

The extent and nature of the demand for extension training which arises from students either preparing for or desiring to complete residence engineering courses; from engineering graduates in active life; and non-engineering graduates who

wish to obtain some grounding in engineering subjects is partially disclosed in Table IV. From this table it is evident that the realization of the need of more extended training is the preponderating factor. If those who took extension courses because they realized the need for more extended training are combined with those who took the work in preparation for a particular job, it is found that 58.5 per cent of all students making replies took extension courses because these courses supplied a deficiency in their earlier training.

TABLE VI.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of University and College Attendants.

Form of Inquiry.	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	Yes.	No.	No Opinion.			Yes.	No.		
Was the personality of your instructor an influential element in your extension work?	62.4	17.6	20.0			78.0	22.0		
Did he willingly and cheerfully answer all inquiries?	90.0	0.6	9.4			99.5	0.5		
Were his comments accurate and complete?	87.6	4.0	8.4			95.6	4.4		
Were his comments and suggestions stimulating and encouraging to greater efforts?	78.2	4.6	17.2			94.5	5.5		
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative influence of extension teacher and residence teacher	3.4	26.3	37.7	32.6	29.7	5.1	38.9	56.0	44.0

The third question for which an answer was sought was the influence of the personality of the extension teacher. As this influence could be measured only relatively, again the opinions of university and college graduates and attendants were tab-

ulated. These answers are given in Tables V and VI and a summary is given in Table VII. To give a correct analysis of, or to epitomize completely these opinions, is extremely difficult. For evidently all opinions do not have the same

TABLE VII.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of University and College Graduates and Attendants Combined.

Form of Inquiry.	Percentage of Total Replies.					Percentage of Replies Expressing Opinion.			
	Yes.	No.	No Opinion.			Yes.	No.		
Was the personality of your instructor an influential element in your extension work?	58.5	22.5	19.0			72.2	27.8		
Did he willingly and cheerfully answer all inquiries?	88.0	1.3	10.7			98.6	1.4		
Were his comments accurate and complete?	85.4	3.6	11.0			96.0	4.0		
Were his comments and suggestions stimulating and encouraging to greater efforts?	74.0	7.5	18.5			91.0	9.0		
	More.	Equal.	Less.	No Opinion.	More + Equal.	More.	Equal.	Less.	More + Equal.
Relative influence of extension teacher and residence teacher	5.2	26.5	37.3	31.0	31.7	7.6	38.4	54.0	46.0

validity or weight. Plainly, the judgment of a young man just out of school is not so cogent as that of a man of mature years and of wide experience. Nevertheless, the recollections and impressions of the young man are probably more keen and vivid than the recollections of one whose school experiences are twenty-five years in the past. Furthermore, some of the replies bear evidence of considerable pondering and thought, while others bear evidence of being mere offhand opinions without much consideration. Some answer posi-

tively while others are non-committal, and after reading considerable circumlocution one is still in doubt as to the writer's real judgment.

When due consideration is given to the maturity, the scholastic training, the practical experience, and the facility of expression of the respondents, one is impressed with the im-

TABLE VIII.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of Normal School, Commercial School, Academy, and Law School Attendants and Graduates.

Form of Inquiry.	Percentage of Total Replies.			Percentage of Replies Expressing Opinion.	
	Yes.	No.	No Opinion.	Yes.	No.
Was the personality of your instructor an influential element in your extension work?	83.3	8.3	8.4	91.0	9.0
Did he willingly and cheerfully answer all inquiries?	97.2	.0	2.8	100.0	.0
Were his comments accurate and complete?	92.0	5.4	2.6	94.0	6.0
Were his comments and suggestions stimulating and encouraging to greater efforts?	86.0	2.7	11.3	97.0	3.0

portance the students attach to the influence of the instructor's personality. If culture can properly be defined as the result of the action and reaction of personalities, the replies show that the students have a keen sense of this reaction when present and of its need when not present. Several of the answers and comments show that the student had a keen appreciation of the importance of this reaction of personalities in any scheme of education. For example, one graduate says:

"I cannot help but feel that the whole 'nib' of this questionnaire is centered about the solution of this last question."

With a realization of the importance attached to their answers, it is surprising to find that 49 per cent of the college

and university graduates testify that the instructor's influence is just as immanent and potent in correspondence instruction as in residence instruction.

The legitimacy of this conclusion is confirmed by an analysis of the replies of university and college attendants but not graduates, 44 per cent of which give a like estimate of the relative influence of the two types of instructors. The difference in the percentages, only 5, is perhaps due to the more vivid recollection of the extension teacher's influence in the first case and of the resident instructor's in the second case, as the second group contains a greater percentage of younger men.

TABLE IX.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of High School Graduates.

Form of Inquiry.	Percentage of Total Replies.			Percentage of Replies Expressing Opinion.	
	Yes.	No.	No Opinion.	Yes.	No.
Was the personality of your instructor an influential element in your extension work?	66.6	10.9	22.5	86.0	14.0
Did he willingly and cheerfully answer all inquiries?	86.0	1.0	13.0	99.0	1.0
Were his comments accurate and complete?	84.0	3.0	13.0	97.0	3.0
Were his comments and suggestions stimulating and encouraging to greater efforts?	80.0	3.3	16.1	96.0	4.0

It is obvious that to measure the influence of the personality of an instructor is extremely difficult if not impossible. However, its importance as an element of a teacher's qualification will not be gainsaid by anyone, and the fact that 46 per cent of those who have had both types of teachers are convinced that the personality of the instructor is as influential through correspondence as through personal contact is a revelation.

Supplementing and supporting the replies of the college graduates and attendants on the influence of the personality of the instructor are the replies of students in the other groups. These replies are tabulated in Tables VIII, IX, and X. These tables summarize the opinions of students who have not attended a technical school, and hence are an indication of the influence of the personality of the extension teacher only. Any opinion concerning the relative influence of extension and residence teachers is omitted.

TABLE X.

INFLUENCE OF PERSONALITY OF EXTENSION TEACHER.

Replies of High School Attendants, Grade School Graduates, and Attendants.

Form of Inquiry.	Percentage of Total Replies.			Percentage of Replies Expressing Opinion.	
	Yes.	No.	No Opinion.	Yes.	No.
Was the personality of your instructor an influential element in your extension work?	69.0	9.0	22.0	88.0	12.0
Did he willingly and cheerfully answer all inquiries?	86.0	.0	14.0	100.0	.0
Were his comments accurate and complete?	85.0	1.5	13.5	98.0	2.0
Were his comments and suggestions stimulating and encouraging to greater efforts?	82.0	1.5	16.5	97.0	3.0

These tables, however, show conclusively that the personality of the extension teacher is a potent influence in stimulating the extension student to greater effort, and that the personality of the extension teacher is an immanent and influential element of his instruction, although the student and teacher may never see each other face to face. For typical replies see Appendix.

CONCLUSION.

An impartial analysis of the replies received gives quite definite answers to the three most important questions sub-

mitted in the introductory letter to the questionnaire. These answers are:

1. With reference to the equivalence and effectiveness of extension courses and instruction, an average of 82 per cent of those qualified to express an opinion state that in so far as content of course and the effectiveness of the instruction is concerned, the extension courses are equal to the courses given in residence.

2. With reference to the development of self-reliance, initiative, originality, and power of expression an average of 92 per cent testify to the equivalence or superiority of extension courses and instruction.

3. The extent and nature of the demand for extension training evidently varies widely, but the preponderating demand is from those who feel the need for further training or for training for a specific job.

The next greatest demand comes from those who are either preparing for college or from those who wish to complete their formal training.

4. While the opinions concerning the relative influence of the personality of the extension and residence instructor vary widely, the conclusion is unavoidable that the influence of the extension teacher, while perhaps not quite so manifest as in residence work, is nevertheless, a very potent factor in the instruction. In short, the personality of the instructor is just as important a factor in one case as in the other.

APPENDIX.

Typical Replies of Students on the Influence of Teacher's Personality.

2. "In the case of an extension teacher the personality is no doubt more apparent than that of a residence teacher whose instructions are to a class, rather than to an individual."

4. "It could be about equal, but I don't think it was in my case."

8. "Influence of personality of extension teacher can not compare with that of the residence teacher unless the residence teacher is very poor. We miss the personal contact. I consider the course valuable, though. It reviews us and grounds us in the theory. We cannot go to school all our lives and as we rapidly lose that which we do not use, it is a means of retaining a broader knowledge."

10. "Personality, as distinct from a knowledge of the subject taught, has less influence in the case of the correspondence teacher. The best informed residence teacher can make a course a bore and actually hinder the progress of his students by deadening their interest and hampering their initiative, but the correspondence student knows little or nothing about his instructor, and is only influenced by the skill with which the latter guides his work."

17. "I believe the better side of the teacher's personality is naturally shown in his letters—just as a voice over the telephone is generally more pleasing than at close range. If the instructor does have a 'bad side' the extension student doesn't know it."

26. "I believe it is impossible for the extension teacher to exert as much personal influence as the residence teacher."

28. "Personality of extension teacher practically nil."

33. "In my case just as influential."

54. "Each seems to have an advantage over the other. The instructor should use every opportunity to make the influence of his personality felt by the student. The student is always eager to have a personal feeling or interest established in his work. In one case I had to ask the name of the instructor grading my work before I could learn his name."

65. "To the extension student, it seems that he is a class of one in whom his instructor is profoundly interested. The instructor carefully refrains from displaying any less desirable traits of his personality. The student forms an unbiased opinion from his own judgment of the instructor. In residence, being in daily contact with the student, the instructor can less successfully conceal any defects in personal-

ity which may exist. The opinion of the student, as well as his attitude toward his instructor and his work, is largely influenced by any display of such defects and by the reaction which they produce in his fellow students."

87. "It is not necessary to see a man to know him—and if Mr.—can teach half as well in residence as he can by correspondence, he is a good teacher."

97. "Think a residence teacher far superior. Correspondence instruction becomes mechanical, impersonal, and often depressing. Teachers work for the fee, and frequently care nothing for the intellectual welfare of the students, but I have found that most university professors eliminate the human element in their work."

102. "Better than residence teacher, in my case."

119. "I do not think an extension teacher can ever take the place of a residence teacher. The personal contact is lacking. I think it is the next best thing, however."

131. "The extension teacher may have as much influence as the residence teacher, though in a different way. From the former, the student may receive more direct instruction than is often possible from the latter, especially in large classes."

132. "I probably do not understand this question. Taking it as I interpret it, I should say there was no difference in the influence of the personality of the instructor, provided that in correspondence instruction the instructor's influence functions at all. However, in the nature of the case the probability is that in correspondence courses the instructor's influence will not be felt unless he makes a definite point of making it felt. On the other hand, in residence instruction the influence of the instructor cannot help but be felt—usually by way of stimulating the student in his work. The one exception, in my experience, has been the man who has adopted an attitude of negation toward life's fundamental values, beauty and truth, a confessed cynic in other words.

I can see no reason why a correspondence teacher cannot exert quite as great a stimulating influence upon his students as the residence teacher. To start with, it seems to me that

it will take less effort for him to establish personal contact with the student, in fact I hardly see how he can avoid thinking of his students as individuals. It is a very simple matter for the resident teacher to think of his "class" as against the individuals in the class. Moreover, in direct contact with the students, I find there are prejudices arise, toward individual students, which require much of the teacher's energy to overcome. I think this is less likely to occur in correspondence.

In short, my personal feeling is that after all the advantages of instruction—in theoretical work—have been taken into consideration, correspondence work, from the point of view of the teacher's influence, may have such a balance of advantages, that it may be made to compare exceedingly well with residence instruction."

Discussion

D. C. Jackson: Mr. President, I will ask Mr. Jansky a question, if he will allow me. The thing that impressed me was the effectiveness with which he made his study, but I observe he speaks in no way of the relative age of students in residence and those who are college graduates or former resident students who are in extension work. It is obvious that those in extension work are the older on the average, because they have already gone through some study in residence. I wonder whether he has given any consideration to that fact with a view to explaining some differences that he may find between the attitude of the extension students and the resident students. In other words, is there greater influence or equal influence of the instructor in the extension methods of Wisconsin which is not so in correspondence courses generally? Is it perhaps due to the fact that the students are more mature and, therefore, recognize the desirability of meeting the instructor on his own ground as it were? Is the effectiveness of the extension teacher as practiced in Wisconsin perhaps partially due to the maturity of the students?

Those questions are not only pertinent, but it seems to me primary and the answers must be before us before we can really utilize the proposals of Professor Jansky successfully.

Mr. Jansky: I think I mentioned that the ages were not averaged; an average age means nothing. The ages of the university graduates, as I stated, range from recent graduates, about twenty-three years, to fifty and sixty years. I averaged the ages of the two university and college groups because I surmised that their opinions were somewhat conditioned by the relative remoteness of their school experiences. The preponderance of opinions that the resident instructor was more influential than the correspondence instructor was found in the second group. The average age of this group is 28 years, and of the first group it is 33 years. The second group contains a greater number of younger men. This, it seems to me, accounts for the difference of five per cent mentioned in the paper.

It is a matter of remembrance. A man's recollection of what took place last week is clearer than it is of what took place twenty-five years ago. The man sixty years of age has forgotten most of his resident instructors though he is acquainted with the correspondence instructor at the time. The conclusion I reach is that you cannot put any mathematical value on these replies. They may point to this: the personality of the instructor is potent in either case. That is the point I am emphasizing.

Mr. Jackson: That doesn't quite answer my question, it partially does. If I understand your statement, it rather emphasizes my point. The way I understood it before was that perhaps the view of the older man as to the effectiveness of the personality of the instructor is based upon the sense of the moment and consequently the correspondence or extension instructor may seem to him more effective, while the younger man who has the two side by side seems to indicate that the resident instructor is more effective.

Mr. Jansky: Yes, I think that is so.

Mr. Jackson: I didn't get the last point from your previous statement. I really wonder if there isn't another factor; that is, whether the relatively greater effectiveness of the extension instructor for the older man may not be due

to his greater maturity. That is what I am really aiming at.

Mr. Jansky: That is perhaps true also, but maturity is not the sole factor. Perhaps it is true primarily for the reason that the correspondence instructor does not come in personal contact with the men.

I am not saying at the present time anything about another type of extension instruction which is coming into vogue at the University of Wisconsin. We are carrying the University of Wisconsin to Milwaukee. Professors Bennett and R. S. McCaffery have been conducting seminar courses there for two years. The data on those courses are not included in this report. They are extension courses of a kind that is going to come more and more to the fore, because there is a demand for them.

Just to liven things up a little, I will read you some of the replies to the question on the influence of the instructor and then I will tell you something about the character of the individuals who wrote them. Taking one offhand, No. 102 says, "Better than residence teacher in my case." Now we will see who 102 is. He is twenty-seven years of age, and a graduate of the University of Wisconsin in mining engineering.

No. 126: "I have known few good practical technical teachers who have a character building personality. The influence of the average technical professor on personality is nil."

No. 126 is twenty-five years of age, from the Colorado School of Mines, a chief engineer.

No. 4: "It could be about equal, but I don't think it was in my case."

No. 4 is a graduate of Johns Hopkins University, twenty-five years of age, a sales engineer.

You can not evaluate these replies numerically, they are merely indicative. Have I answered your questions?

Mr. Jackson: You have. I want to add one thing. I think we are greatly indebted to Professor Jansky for bringing this idea forward. With this paper of his and with the wealth of data as well as experience which they have in the Exten-

sion Department of the University of Wisconsin, it is possible that Professor Jansky could give us further light on the question of how far we ought to go in extending our expenditures for residence apparatus and residence teachers and how far we can reduce that expenditure and still maintain the character of work we wish to do.

I will speak of the non-resident work that Mr. Jansky spoke of from the standpoint of the graduate. One of the great electrical manufacturing companies has one of its largest establishments in one of the suburban towns, virtually in Boston. That company through the officers of its shops stated that they would like to have some graduate work carried on for the benefit of their younger engineers by the Electrical Engineering Department of the Massachusetts Institute of Technology. They later asked also the Mechanical Engineering Department to undertake it.

We have taken that up, it being understood that only men who are engineering graduates from good schools and who are prepared to take our graduate work shall go into it; at least, if they are not fully prepared they must prepare before they can go into it. The conditions are such that the men may get our degree. They will do about half the work while they are in the shop and the other half while on leave of absence at the Institute of Technology. Their researches and so on are carried on finally there.

The plan has been in effect now for one entire year and has gone very well. There is a greater call for it than we thought there would be. The second year starts auspiciously with respect to applications for admission. The young men are only those whom the company has had in its employ for a year and is willing to recommend as desirable for such study and to whom it is willing to grant a leave of absence of a half year within two years on pay or under some consideration. So they are good men.

Notwithstanding all those circumstances with which the choice has been surrounded to make sure that they are properly qualified students, I have found a great deal of

criticism amongst the engineering school men of our undertaking such an enterprise. But I have found no criticism of it in the industry. I am wondering whether the engineering school men may not be a bit over-conservative in regard to this particular matter. I will add that the work is carried on with the full authority of the faculty of the Massachusetts Institute of Technology, and I am, therefore, not speaking of any criticism among the faculty. I am speaking of criticism that has come to me from others; one man after another.

Mr. Jansky: I would like to make one or two remarks on that though I will not discuss it in detail. The conservatism that Professor Jackson has mentioned is inherent in human nature. I am inclined to believe that conservatism is to a great extent the result of pride of possession and not always the result of acquaintance with other means of instruction or with other things. An individual will buy a medium priced automobile and immediately it is the equal of a Packard. Why? Because it is his. Our literary brothers have been educated along certain lines and by certain processes. Consequently they believe these lines and these processes unique in the acquisition of a liberal education. Why? You can draw your own conclusions.

As far as correspondence instruction is concerned, I have had experience not only as an instructor but also as a student. The instructor, Professor Hoover of the Ohio University, made me feel as well acquainted with him as I was with the instructors who were over me at the university, and I accomplished, I am perfectly frank to say, more than I did in residence.

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PUBLICATIONS OF THE BOARD OF INVESTIGATION AND COORDINATION.

Form.—The permanent publications of the Board will appear in three distinct forms. They will be published serially in the Journal of Engineering Education in order to place the entire body of material in the hands of the individual membership of the Society; they will be published in pamphlet form as a series of Bulletins and Reports, designed to provide convenient work material for faculty committees and means of reaching persons with particular interests; and they will subsequently be collected in substantial bound volumes for preservation and reference.

Free Circulation.—Individual members of the Society will normally receive this material through the Journal, and may purchase it in pamphlet or book form at a nominal cost. A copy of each publication of the Board will be sent without charge to the president and to the dean or other administrative head of each engineering college or division of every institution in the United States and Canada which grants degrees in engineering. A copy of each publication will also be supplied to the several chairmen of faculty committees on educational policy appointed in conjunction with the Board's general program. Libraries will be supplied with the bound volumes without charge.

Circulation Through Local Institutions.—The Board suggests that the heads of the engineering colleges act as the principal channels through which to bring the work and fruits of the investigation to the attention of certain groups within their respective spheres of influence. These groups include:

a. Heads of non-engineering colleges or departments in the same or other institutions;
b. Regents, trustees and members of visiting committees;
c. Members and officers of State Boards of Education;
d. Principals of secondary schools; and
e. Influential alumni.

While it may be worth while to supply complete sets of publications in some cases, it will probably be more effective, as a general rule, to make a selection of particularly relevant material and to transmit it with some personal communication calling attention to its character and significance. This is a matter for local initiative and handling, and to be accomplished, in general, at local expense.

Sale of Publications.—The Board meets the expense of the publication of its material in the Journal of Engineering Education. Publications in pamphlet and book form are priced to cover only the cost of reprinting, binding and handling. They may be obtained in any desired quantity from the Lancaster Press, Prince and Lemon Streets, Lancaster, Pa. A list of the publications now available and their prices is appended.

Publications Now Ready, with Prices.

Preliminary Report of the Board of Investigation and Coordination ..... 20 cents.
Preliminary Report of the Director to the Board and to the Society ..... 15 cents.
Summary of the Fact-Gathering Stages of the Investigation ..... 15 cents.
Bulletin No. 1, Engineering Students at the Time of Entrance to College ..... 20 cents.
Bulletin No. 2, Admissions and Eliminations of Engineering Students ..... 20 cents.
Bulletin No. 3, Engineering Graduates and Non-Graduate Former Students ..... 20 cents.
Bulletin No. 4, Engineering Teaching Personnel ...20 cents.
Bulletin No. 5, Supplementary Activities of Engineering Colleges ..... 15 cents.
Bulletin No. 6, Costs of Engineering Education .. 15 cents.
Bulletin No. 7, Engineering Degrees ..... 15 cents.
Bulletin No. 8, A Study of a Group of Electrical Engineering Graduates ..... 15 cents.
Bulletin No. 9, A Summary of Opinions Concerning Engineering Curricula ..... 20 cents.

Publications in Preparation.

Bulletin No. 10, Analysis of Curricula and Entrance Requirements of Engineering Colleges.

Bulletin No. 11, Evolutionary Changes in Engineering Curricula, 1870–1924.

Bulletin No. 12, The Cooperative Method of Engineering Education.

Bulletin No. 13, Special Inquiries in Engineering Education by National Engineering Societies.

Bulletin No. 14, Placement Examinations as Measures of Preparation and Ability.

Bulletin No. 15, Agencies for the Accrediting of Secondary Schools.

Bulletin No. 16, The Economic Content of Engineering Curricula.

Bulletin No. 17, Causes of Failure and Elimination of Engineering Students.

Bulletin No. 18, The Relations of Professional Organizations and Professional Schools.

Bulletin No. 19, Engineering Education in Europe.

Bulletin No. 20, Engineering Education and the Manufacturing Industries.

THE ENGLISH DEPARTMENT

There is one sentence in the Preliminary Report of the Board of Investigation and Coördination recently presented for discussion by the Association of Deans in Washington that has great significance for the Committee on English. In fact it so well formulates the ideal toward which this committee has been working for the past decade that it comes as a rather startling sanction of the general agreement reached in the joint conference of deans and teachers of English held in June at Iowa City.

The sentence reads as follows:

"There should be a band of humanistic subjects extending throughout the curriculum. To increase the range of such work available in addition to the required work in English and economics, much of it may properly be on an elective basis."

The discussion at the Iowa City meeting gave striking evidence that English composition is now generally recognized as an important and integral part of the training of the engineering student. He must be able to write and to speak or he is doomed to find himself without the means of delivering his ideas. The courses in freshman composition are developing a high order of efficiency. They are being more and more correlated with the other courses the student is taking; they are given life and vivid motive by a recognition of special interests of the student. Moreover there is a growing sense of responsibility throughout our faculties for coöperative effort in establishing habits of correct usage. All this is more or less past history, although it does represent a real achievement on the part of our colleges.

But the evidence was also clear from the discussion at that really significant meeting that the engineering colleges are at the beginning of a new epoch in the development of their

work in English. The tool value of English is being subordinated to its longer humanistic value. Courses in Freshman English are beginning to take on a new function. They must somehow intrigue the boy's interest in reading; they must dissipate the prejudices against the study of literature with which he often comes from high school; they must somehow develop a critical standard which will serve him in his choice of books and plays. Thus the English courses required of the freshmen are beginning to combine certain ideal values with those very practical ones claimed for them in the past.

Even more noticeable is the tending to extend the work in English over a longer period. The one-semester course becomes two. There is added an advanced course to be taken in the sophomore year. A junior or senior course is offered for those who can afford the time. Sometimes these developments represent the ambitions and ideals of the English teachers but, happily enough, they also often represent the demand of the students themselves. It is often almost pathetic to see how much they want these finer things of the spirit to balance the grind of their technical studies. Case School of Applied Science reported that when last year an elective course in literature was offered, thirty students elected it, although it met at the lunch hour, was elected as an extra subject, and gave no credit for graduation. Such an instance is quite typical of what is often the initial impulse toward the extension of the English work by the development of elective courses. At Purdue University where the work is highly developed, Professor Creek reported that in addition to four semesters of required English in the freshman and sophomore years, about 120 juniors and 100 seniors have elected courses not required for graduation. At the University of Michigan, where the work in English has been evolving for twenty-seven years contemporaneously with the rest of the engineering curriculum, fifteen elective courses, most of them in literary appreciation and criticism, are offered. It is a source of some pride to that college that 60 per cent of the students enrolled in English are in elective courses. These cases are typical.

From the college with a reading list as its one means of encouraging the students' interest in good literature to the colleges with highly developed systems of elective courses, there is everywhere evident a growth in interest in the study of literature.

How beautifully it illustrates the ideal condition which that inspired sentence in the Report of the Board of Investigation so happily presages. The interpenetration of the curriculum of technical studies by the English courses has been a matter of natural expansion. It has been aided by no propaganda, nor animated by any very conscious pedagogical theory. Our students have been interested and we responded to that interest. But here it is coming to pass, the very thing ought to be. Here is the band of English courses extending throughout the four years of the curriculum. And the range of those courses is enormously widened and their humanistic effort greatly deepened by the fact that they are so largely on an elective basis.

The Committee on English hopes to be of service to engineering education by doing all it can to encourage the extension of the work in English in our engineering colleges by the development of elective courses. It solicits correspondence regarding the matter. Address J. Raleigh Nelson, Chairman, 927 Forest Ave., Ann Arbor, Michigan.

MINUTES OF THE MEETING OF THE COUNCIL OF THIS SOCIETY, COSMOS CLUB, WASHINGTON, D. C., NOVEMBER 18, 1926

Present: G. C. Anthony, F. L. Bishop, G. M. Braune, B. M. Brigman, W. K. Hatt, D. C. Jackson, M. S. Ketchum, O. M. Leland, Anson Marston, C. V. Mann, C. H. Mitchell, E. B. Norris, G. B. Pegram, Harold Pender, A. A. Potter, R. I. Rees, W. S. Rodman, R. A. Seaton, C. F. Scott, F. E. Turneaure, J. W. Votey, W. E. Wickenden, P. F. Walker. Also C. E. Seashore and H. P. Hammond by invitation.

Professor D. C. Jackson reported progress on the Lamme medal.

It was moved that the 1927 meeting of the Society be held at the University of Maine the week beginning June 27, 1927, unless their summer term begins that week. In that case the meeting will be held the week of June 20, 1927. The exact time was left to President Boardman of the University of Maine and the Executive Committee of this Society.* Carried.

Professor C. F. Scott, Chairman, Board of Investigation and Coördination, made a statement regarding the work of the Board of Investigation and Coördination. "The meeting to be held at this time in Washington is a joint meeting of the Board and the Division of Deans and Administrative officers, arrangements for which were made at the suggestion of the Board at the Iowa City Convention. The first or fact finding stage of the investigation is now coming to its completion and the present meeting is planned for the inauguration of action by the schools.

"The Board is preparing its report in two parts, the first relating to the facts and the second to conclusions and recommendations. The facts are to be presented in pamphlets,

* Since this action the date of the meeting has been set, beginning Monday afternoon, June 27, and closing Thursday, June 30.

nine of which are now printed. There is also at hand a preliminary report of the conclusions and recommendations which is also in printed form. These pamphlets are now officially presented to you as the progress report of the Board.

"A general statement on behalf of the Board will be made by President Aydelotte at the dinner this evening and at the session tomorrow Messrs. Wickenden and Hammond will present the report. You will find that the Board proposes six points for consideration and action by the schools. These were carefully selected at a three day meeting of the Board in Pittsburgh held last month. They were then put in form by the staff and again submitted to the Board. The comments were reviewed by the publication committee and again revised by the staff and now appear in the printed report.

"Regarding funds, it was reported to you at the Iowa City Convention that the Carnegie Corporation does not see its way clear to finance the second stage of our activities. We had a conference with Dr. Keppel to ascertain his attitude toward our work. When asked if we could say that he endorsed the continuation of our movement he said that we could put the endorsement in stronger terms by saying that the Trustees of the Carnegie Corporation are fully satisfied with what has been done and hope and expect that it will be continued. He further stated that if a slight extension of the funds which they had granted were needed for completing the first stage of our work it would be furnished and we have since then received the additional check for $10,000.

"It was reported at the Iowa City Convention that the Presidents of the Founders Societies would recommend to their boards the endorsement and support of our project. The boards of these national engineering societies have recommended to their finance committees that appropriations be made approximating a total of $5,000 for 1927, and also for 1928. Engineering Foundation has contributed $1,000 for each of the two years. One of our leading industries has subscribed $5,000 per year for each of two years contingent on

the general carrying out of the plan as projected. The Guggenheim Foundation for the Promotion of Aviation has sent a check for $2,500.

"The Fund Committee of the Board has been augmented by two representatives from each of the foundation societies appointed by the respective societies. Engineering Foundation is acting as treasurer and its director, Mr. Flinn, and your Chairman have prepared with the coöperation of the committee a letter which has been sent to a number of industrial corporations. The letters were sent out about three weeks ago and we are receiving replies, some asking for further information or for further time and others indicating that no funds are available. The committee will welcome your cooperation and assistance in bringing the matter before the proper officials of industrial companies or others who may appreciate the value of our work and be ready to contribute to it."

Mr. W. E. Wickenden, Director of Investigations, reported the work which had been accomplished and outlined the report which would be presented to the deans and administrative officers of all engineering schools on Friday.

Forty-one applicants for membership were elected. They are:

BARNES, GARNETT F., Associate Professor of Physics, A. & M. College of Mississippi, A. & M. College, Miss.

BROWN, FREDERICK L., Associate Professor of Physics, University of Virginia, University, Va.

BROWN, WESLEY B., Assistant Professor of Electrical Engineering, Vanderbilt University, Nashville, Tenn.

CRAWFORD, WILLIAM W., Instructor in Civil Engineering, Kansas State Agricultural College, Manhattan, Kans.

CUTLER, ALVIN S., Professor of Railway Engineering, University of Minnesota, Minneapolis, Minn.

DANIEL, CHARLES M., Assistant Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga.

DAVEY, WHEELER P., Professor of Industrial Research and Physical Chemistry, The Pennsylvania State College, State College, Pa.

DOLVE, ROBERT M., Professor of Mechanical Engineering, North Dakota Agricultural College, Fargo, N. D.

DUNCAN, DAVID C., Professor of Physics, The Pennsylvania State College, State College, Pa.

EATON, LEON S., Associate Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr.

EVINGER, MORRIS I., Professor of Hydraulic and Sanitary Engineering, University of Nebraska, Lincoln, Nebr.

FINNEGAN, JOSEPH B., Professor of Fire Protection Engineering, Armour Institute of Technology, Chicago, Ill.

FLAGG, RAY, Professor of Mechanical Engineering, A. & M. College of Texas, College Station, Texas.

FOLLOWS, GEORGE H., Professor of Commercial Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

FOSTER, IRVING L., Professor of Romance Languages, The Pennsylvania State College, State College, Pa.

GAINES, BENJAMIN F., Assistant Professor of Mechanical Engineering, University of Florida, Gainesville, Fla.

GARMAN, WARREN D., Assistant Professor of Mechanical Engineering, Alabama Polytechnic Institute, Auburn, Ala.

GAUGER, ALFRED W., Director, Division of Mines and Mining Experiments, University of North Dakota, Grand Forks, N. D.

HART, CLARENCE A., Assistant Professor of Civil Engineering, Purdue University, LaFayette, Ind.

HENDERSON, CHARLES, Assistant Professor of Experimental Engineering, University of Virginia, University, Va.

HOEKE, FRED A., Engineer, General Electric Company, 866 W. Peachtree Avenue, Atlanta, Ga.

HOWLAND, WARREN E., Instructor, Purdue University, LaFayette, Ind.

KEENAN, ERNEST C., Professor of Applied Mathematics, Syracuse University, Syracuse, N. Y.

KING, GEORGE C., Professor of Mechanical Engineering Design, Purdue University, LaFayette, Ind.

LEWIS, FRED J., Associate Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn.

LIND, SAMUEL C., Director, School of Chemistry, University of Minnesota, Minneapolis, Minn.

MANDERFIELD, NICHOLAS H., Assistant Professor of Metallurgy and Ore Dressing, Michigan College of Mines, Houghton, Mich.

MATHESON, ERNEST G., Associate Professor of Civil Engineering, University of British Columbia, Vancouver, B. C.

MILLS, GEORGE H., Instructor in Electrical Engineering, Case School of Applied Science, Cleveland, Ohio.

MUELLER, GEORGE V., Instructor in Electrical Engineering, Purdue University, LaFayette, Ind.

MURDOUGH, JAMES H., Associate Professor of Civil Engineering, Texas Technological College, Lubbock, Texas.

OWENS, FREDERICK W., Head, Department of Mathematics, The Pennsylvania State College, State College, Pa.

RIES, EMIL D., Associate Professor of Chemical Engineering, The Pennsylvania State College, State College, Pa.

RISING, JUSTUS, Associate Professor of Practical Mechanics, Purdue University, LaFayette, Ind.

ROSS, JOHN A., JR., Professor of Mechanical Engineering, Clarkson College of Technology, Potsdam, N. Y.

RUGG, RUTH G., Reference Assistant, Library, Purdue University, LaFayette, Ind.

STAFFORD, JOHN W., Instructor in Electrical Communications, Purdue University, LaFayette, Ind.

TODD, MARION W., Assistant Professor of Topographical Engineering, Purdue University, LaFayette, Ind.

ULLMANN, HARRY M., Professor of Chemistry and Chemical Engineering, Lehigh University, Bethlehem, Pa.

WALTERS, JACK E., Director of Personnel, Schools of Engineering, Purdue University, LaFayette, Ind.

WILLIAMS, COLE A., Professor of Steam Engineering, Purdue University, LaFayette, Ind.

WILCOX, GUY M., Professor of Physics, Armour Institute of Technology, Chicago, Ill.